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PLANETARY PHENOMENA FOR MARCH AND APRIL, 1896.

By Professor Malcolm McNeill.

March.

The vernal equinox, when the Sun crosses the equator from south to north, occurs on March 19th, at about 6 P. M., P. S. T.

Mercury is a morning star throughout the month, and comes to greatest west elongation 27° 20′ on March 5th; but, on account of the fact that it is about ten degrees south of the Sun, the conditions for visibility are not very good. During the first ten days of the month, it rises a little more than an hour before sunrise, and may possibly be seen under good weather conditions.

Venus is still a morning star, but it is overtaking the Sun in its eastward motion among the stars, and, by the end of the month, it rises less than an hour before sunrise. On the morning of March 14th, it passes six minutes south of the fifth magnitude star *μ Capricorni*. The time of nearest approach is about 5 A. M., P. S. T., about the time of its rising in the extreme western part of the United States.

Mars rises about two hours before sunrise throughout the month. During the month it moves about twenty-three degrees eastward and six degrees northward in the constellation *Capricornus*, increasing its apparent distance from the Sun about four degrees. It is coming a little nearer to the Earth in actual distance, but it is still distant from us about twice the mean distance of the Earth from the Sun; and it is gradually growing a little brighter, but the gain is small as yet.

Jupiter is still in fine position for observation, being above the horizon until quite late at night, or, rather, early morning. It is

in the constellation *Cancer*, and, up to March 24th, moves about one degree westward. It then begins to move slowly eastward. It is about five degrees west of the "Beehive" cluster *Præsepe*.

Saturn is gradually getting into favorable position for evening observation, rising at $9^h\ 21^m$ at the end of the month. It is in the constellation *Libra*, and during the month moves about one degree westward and northward. The opening of the rings is quite a little wider than it was last year, the minor axis being more than one-third of the major.

Uranus follows about four degrees after *Saturn*, and three degrees south of it. It is on the borders of the constellations *Libra* and *Scorpio*, and during the month moves about five-tenths of a degree westward.

Neptune is in the eastern part of the constellation *Taurus*, too faint to be seen without a good telescope.

April.

Occultations. The planet *Mars* will be occulted by the Moon on the morning of April 8th. The occultation will be visible in the eastern part of the United States, the planet rising occulted, and coming into view shortly after. The occultation will be over before planet and Moon rise in the western part of the country. On the evening of April 15th, the Moon will again occult the *Pleiades* group, and quite a number of occultations may be seen from almost any part of the country. The Moon is only three days old, and the emersions at the dark limb will be quite striking phenomena. There will be other occultations of the *Pleiades* during the year, in August, October, and November, which can be observed in the United States.

Mercury is a morning star at the beginning of the month, passes superior conjunction on the evening of April 17th, and becomes an evening star. It rapidly increases its apparent distance from the Sun, and, by the end of the month, sets more than an hour and a quarter after sunset; so it may easily be seen under good weather conditions. It will then remain visible on every clear evening for about a month.

Venus is still a morning star, but is drawing nearer the Sun in their apparent eastward motion, and rises only forty minutes earlier at the end of the month. It is in aphelion on April 1st.

Mars is gradually increasing its apparent distance from the Sun, and is rising a little earlier. It is also gaining in brightness,

but will not become conspicuous until late in the summer. It moves twenty-two degrees eastward and eight degrees northward during the month, from the constellation *Capricornus*, through *Aquarius*, and into *Pisces*.

Jupiter is still in fine position in the southwestern sky in the early evening. It does not set until long after midnight. It moves about two degrees eastward in the constellation *Cancer*, toward the "Beehive" cluster.

By the close of the month, *Saturn* rises just after sunset; and is in good position for observation late in the evening at any time during the month. It is in the constellation *Libra*, and during the month it moves about two degrees westward and northward toward *α Libræ*, being about three degrees distant on April 30th.

Uranus follows about five degrees after *Saturn*. It is also moving westward, but only about half as fast as *Saturn*.

Neptune is in the eastern part of *Taurus*.

Explanation of the Tables.

The phases of the Moon are given in Pacific Standard time. In the tables for Sun and planets, the second and third columns give the Right Ascension and Declination for Greenwich noon. The fifth column gives the local mean time for transit over the Greenwich meridian. To find the local mean time of transit for any other meridian, the time given in the table must be corrected by adding or subtracting the change per day, multiplied by the fraction whose numerator is the longitude from Greenwich in hours, and whose denominator is 24. This correction is seldom much more than 1^m. To find the standard time for the phenomenon, correct the local mean time by *adding* the difference between standard and local time if the place is west of the standard meridian, and *subtracting* if east. The same rules apply to the fourth and sixth columns, which give the local mean times of rising and setting for the meridian of Greenwich. They are roughly computed for Lat. 40°, with the noon Declination and time of meridian transit, and are intended as only a rough guide. They may be in error by a minute or two for the given latitude, and for latitudes differing much from 40° they may be several minutes out.

Phases of the Moon, P. S. T.

		H. M.
Last Quarter,	Mar. 6,	3 29 A. M.
New Moon,	Mar. 14,	2 48 A. M.
First Quarter,	Mar. 22,	3 57 A. M.
Full Moon,	Mar. 28,	9 21 P. M.

The Sun.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Mar. 1.	22 52	− 7 16	6 34 A. M.	12 12 P.M.	5 50 P.M.
11.	23 29	− 3 24	6 20	12 10	6 0
21.	0 5	+ 0 33	6 3	12 7	6 11
31.	0 41	+ 4 28	5 47	12 4	6 21

Mercury.

Mar. 1.	21 8	− 16 15	5 26 A.M.	10 29 A.M.	3 32 P.M.
11.	21 50	− 14 31	5 21	10 31	3 41
21.	22 43	− 10 28	5 21	10 45	4 9
31.	23 43	− 4 20	5 20	11 6	4 52

Venus.

Mar. 1.	20 43	− 18 19	5 8 A.M.	10 4 A.M.	3 0 P.M.
11.	21 33	− 15 13	5 7	10 14	3 21
21.	22 21	− 11 25	5 2	10 23	3 44
31.	23 7	− 7 5	4 54	10 30	4 6

Mars.

Mar. 1.	20 3	− 21 21	4 41 A.M.	9 24 A.M.	2 7 P.M.
11.	20 35	− 19 45	4 26	9 16	2 6
21.	21 6	− 17 50	4 10	9 8	2 6
31.	21 36	− 15 37	3 53	8 59	2 5

Jupiter.

Mar. 1.	8 9	+ 20 52	2 14 P.M.	9 28 P.M.	4 42 A.M.
11.	8 7	+ 21 0	1 32	8 47	4 2
21.	8 6	+ 21 3	12 51	8 6	3 21
31.	8 6	+ 21 2	12 12	7 27	2 42

Saturn.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Mar. 1.	15 9	− 15 10	11 24 P. M.	4 31 A.M.	9 38 A.M.
11.	15 9	− 15 6	10 44	3 52	9 0
21.	15 8	− 14 59	10 3	3 11	8 19
31.	15 6	− 14 50	9 21	2 30	7 39

Uranus.

Mar. 1.	15 29	− 18 37	11 56 P.M.	4 51 A.M.	9 46 A.M.
11.	15 29	− 18 36	11 16	4 11	9 6
21.	15 28	− 18 34	10 36	3 31	8 26
31.	15 27	− 18 31	9 56	2 51	7 46

Neptune.

Mar. 1.	4 57	+ 21 13	11 2 A.M.	6 16 P.M.	1 30 A.M.
11.	4 57	+ 21 14	10 23	5 37	12 51
21.	4 57	+ 21 15	9 44	4 58	12 12
31.	4 58	+ 21 17	9 4	4 20	11 36 P.M.

Eclipses of *Jupiter's* Satellites, P. S. T.

(Off right-hand limb, as seen in an inverting telescope.)

		H. M.			H. M.
I, R,	Mar. 1.	6 35 P. M.	II, R,	Mar. 20.	3 20 A. M.
III, D,	5.	4 10 A. M.	I, R,	23.	12 20 A. M.
II, R,	5.	10 10 P. M.	II, R,	23.	4 38 P. M.
I, R,	7.	2 0 A. M.	I, R,	24.	6 49 P. M.
I, R,	8.	8 30 P. M.	III, D,	26.	4 9 P. M.
I, R,	10.	2 59 A. M.	III, R,	26.	7 42 P. M.
IV, D,	10.	11 50 P. M.	IV, D,	27.	5 53 P. M.
II, R,	13.	12 45 A. M.	IV, R,	27.	10 33 P. M.
I, R,	15.	10 25 P. M.	I, R,	30.	2 15 A. M.
I, R,	17.	4 54 P. M.	II, R,	30.	7 13 P. M.
III, R,	19.	3 42 P. M.	I, R,	31.	8 44 P. M.

Phases of the Moon, P. S. T.

		H. M.
Last Quarter,	Apr. 4,	4 24 P. M.
New Moon,	Apr. 12,	8 23 P. M.
First Quarter,	Apr. 20,	2 47 P. M.
Full Moon,	Apr. 27,	5 47 A. M.

THE SUN.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Apr. 1.	0 45	+ 4 51	5 46 A.M.	12 4 P.M.	6 22 P.M.
11.	1 22	+ 8 37	5 30	12 1	6 32
21.	1 59	+ 12 8	5 15	11 59 A.M.	6 43
May 1.	2 37	+ 15 19	5 2	11 57	6 52

MERCURY.

Apr. 1.	23 50	− 3 37	5 20 A.M.	11 8 A.M.	4 56 P.M.
11.	0 57	+ 4 27	5 21	11 36	5 51
21.	2 13	+ 13 26	5 27	12 13 P.M.	6 59
May 1.	3 34	+ 20 58	5 39	12 54	8 9

VENUS.

Apr. 1.	23 12	− 6 38	4 54 A.M.	10 30 A.M.	4 6 P.M.
11.	23 57	− 1 58	4 43	10 36	4 29
21.	0 42	+ 2 51	4 32	10 42	4 52
May 1.	1 28	+ 7 35	4 22	10 48	5 14

MARS.

Apr. 1.	21 39	− 15 22	3 51 A.M.	8 58 A.M.	2 5 P.M.
11.	22 9	− 12 54	3 33	8 48	2 3
21.	22 38	− 10 13	3 13	8 38	2 3
May 1.	23 6	− 7 24	2 52	8 27	2 2

JUPITER.

Apr. 1.	8 6	+ 21 2	12 8 P.M.	7 23 P.M.	2 38 A.M.
11.	8 8	+ 20 57	11 31 A.M.	6 46	2 1
21.	8 10	+ 20 48	10 55	6 9	1 23
May 1.	8 14	+ 20 35	10 21	5 34	12 47

SATURN.

Apr. 1.	15 6	− 14 49	9 17 P.M.	2 26 A.M.	7 35 A.M.
11.	15 3	− 14 38	8 34	1 44	6 54
21.	15 1	− 14 26	7 52	1 2	6 12
May 1.	14 58	− 14 14	7 9	12 20	5 31

URANUS.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Apr. 1.	15 27	− 18 30	9 52 P.M.	2 47 A.M.	7 42 A.M.
11.	15 26	− 18 26	9 11	2 6	7 1
21.	15 24	− 18 21	8 30	1 26	6 22
May 1.	15 23	− 18 15	7 49	12 45	5 41

NEPTUNE.

Apr. 1.	4 58	+ 21 17	9 0 A.M.	4 16 P.M.	11 34 P.M.
11.	4 59	+ 21 19	8 22	3 38	10 54
21.	5 0	+ 21 21	7 44	3 0	10 16
May 1.	5 2	+ 21 23	7 6	2 23	9 40

ECLIPSES OF *JUPITER'S* SATELLITES, P. S. T.

(Off right-hand limb, as seen in an inverting telescope.)

		H. M.			H. M.
III, D,	Apr. 2.	8 9 P. M.	II, R,	Apr. 14.	12 23 A. M.
III, R,	2.	11 41 P. M.	I, R,	15.	12 35 A. M.
II, R,	6.	9 48 P. M.	I, R,	16.	7 4 P. M.
I, R,	7.	10 40 P. M.	II, R,	21.	2 58 A. M.
I, R,	9.	5 9 P. M.	I, R,	22.	2 31 A. M.
III, D,	10.	12 9 A. M.	I, R,	23.	8 59 P. M.
IV, R,	13.	4 39 P. M.	I, R,	30.	10 55 P. M.

THE PHOTOGRAPHY OF PLANETOIDS, BY PROFESSOR MAX WOLF.

ABSTRACT BY DR. EDWARD S. HOLDEN.

The *Astronomische Nachrichten* No. 3319 contains an exhaustive paper by Professor MAX WOLF, of Heidelberg, on the photography of planetoids, based on his personal experience in the years 1891–1895. His work has been done with portrait lenses of five and of six inches aperture, with foci of twenty-five and of thirty inches, respectively. The lens is kept accurately pointed for exposures of one and one-half, or, better, two hours, and the stars appear as *dots* on the plate, while asteroids are distinguished by their (short) *trails*.

To draw safe conclusions from such observations, the plates must be in duplicate. If both plates are simultaneously exposed,

errors on one plate may make the result doubtful. Professor WOLF prefers to expose plate A for one hour, then to begin the exposure of plate B, to close plate A after another hour, and, finally, to close plate B at the end of the third hour. Part of the space occupied by the *trail* of a planetoid on A will be vacant on plate B, and *vice versa.*

If a visual telescope of sufficient power is at hand, the shortest method is to expose one plate only, and to examine the sky with the visual telescope to resolve the doubtful points suggested by the plate. This is the method so successfully followed by M. CHARLOIS at Nice.

An important advantage of this method of research is the wide field covered by the portrait lens.*

For planetoids brighter than 12.6 magnitude, Professor WOLF finds that a field of some seventy square degrees is available under good conditions.

To compare two plates, A and B, both plates are laid on a retouching frame, one over the other, with both films downwards, and are then examined with a hand-glass. This method is found by Professor WOLF, after long experience, to be preferable to other processes, suggested by Messrs. E. C. PICKERING, BARNARD, and by WOLF and LENARD.

Whenever it is possible, the R. A. and Dec. of the planet should be obtained from visual observations, and not from plates made with portrait lenses of short focus. If portrait lenses of sixteen inches aperture and eighty-odd inches focus are available (such as the Heidelberg Observatory expects to possess), the case is different, and good positions can be had from the plates. The estimation of the magnitude of the planet from its *trail* requires long experience, and is always difficult. The measurement of positions on photographic plates is attended by a swarm of difficulties, which have been considered in detail by Professor WOLF in *Astronomy and Astrophysics* for 1893, page 799, to which reference is made.

During the past years, Professor WOLF has experimented with all kinds of developers, and concludes that, in respect of the energy of the development, there is little to choose between them. He generally employs *Rodinal* in its commercial form, using ninety parts of water to ten of Rodinal, and not developing

* This point was laid before the International Astro-Photographic Congress by Messrs. E. C. PICKERING and STEINHEIL, but such lenses were rejected for the International Map.

too long,—that is, the plate is not allowed to become too dark. By long and careful researches, Professor WOLF also concludes that he can secure somewhat fainter impressions on the plate by a strong developer acting for a short time than by a weak one used for a long development. So-called restrainers, as Sodium-bromide, should not be employed. They produce a clear film, but the fainter impressions are lost.

These remarks relate to the photography of planetoids, etc., and are not applicable to photographs of nebular *details*, etc., to photographs of the Sun and Moon, etc. In such cases the *Glycin* developer is to be recommended, using *fresh* plates. For planetoids and faint nebulæ, old plates and a rapid development are desirable.

From the tables in Professor WOLF's paper, it results that in

1892,	38	known	and	18	new	planetoids	were	found	by	him.
1893,	27	"	"	9	"	"	"	"	"	"
1894,	15	"	"	6	"	"	"	"	"	"
1895,	19	"	"	3	"	"	"	"	"	"

or, one new planetoid was found

to 2.1	known	planetoids	in	1892.
to 3.0	"	"	"	1893.
to 2.5	"	"	"	1894.
to 6.3	"	"	"	1895.

It would seem, from this table, as if the number of the unknown planetoids as bright as the twelfth magnitude had been materially reduced, though it is probably too soon to draw this conclusion.

When one reviews the work that has been done in this field in order to see how far the photographic method of discovering planetoids has succeeded, the result is most satisfactory.

By means of the photographic method, many new planetoids have been discovered, and, what is at least as important, many old planets which had been "lost" have been re-discovered,—which would hardly have been the case had we depended solely on visual observations.

As in other fields of research, it has been found that photography, so far from doing away with the necessity for visual observations, has, in fact, created new demands upon the former methods, and has increased, not diminished, its scope and usefulness.

In a foot-note, Professor WOLF remarks that he feels obliged,

on account of the pressure of other work, and on account of his present state of health, to abandon the field of the discovery of planetoids by photography. In the four years of his work, he has discovered no less than thirty-six new asteroids, and has re-discovered many of those which were "lost," and he may leave the methods which he has created to other most capable observers, well content with his own contributions to this branch of science. By the time the Heidelberg Observatory obtains its pair of great photographic lenses,* it is hoped that Professor WOLF may be in robust health, and ready to use them in new fields. If there is an unknown major planet, the best hope for its discovery is by these lenses or by the BRUCE telescope of the Harvard College Observatory, or by some instrument of like class, with a large field and great light-gathering power.

E. S. H.

(TWENTIETH) AWARD OF THE DONOHOE COMET-MEDAL.

The Comet-Medal of the Astronomical Society of the Pacific has been awarded to Mr. C. D. PERRINE, Assistant-Astronomer in the LICK Observatory for his discovery of an unexpected comet on November 17, 1895.

The Committee on the Comet-Medal,

EDWARD S. HOLDEN,
J. M. SCHAEBERLE,
W. J. HUSSEY.

January 17, 1896.

(TWENTY-FIRST) AWARD OF THE DONOHOE COMET-MEDAL.

The Comet-Medal of the Astronomical Society of the Pacific has been awarded to Professor W. R. BROOKS of Geneva, N. Y., for his discovery of an unexpected comet on November 21, 1895.

The Committee on the Comet-Medal,

EDWARD S. HOLDEN,
J. M. SCHAEBERLE,
W. J. HUSSEY.

January 21, 1896.

* See *Publications* A. S. P., Vol. VII, p. 285.

NOTICES FROM THE LICK OBSERVATORY.

PREPARED BY MEMBERS OF THE STAFF.

ASTRONOMICAL INSTRUMENTS MAKING IN WASHINGTON.

A letter from Mr. SAEGMÜLLER, of Washington, D. C., notifies that during the past year his works have completed a nine-inch *photographic* transit-instrument, with collimators, for the observatory of Georgetown College; that a four-and-one-half-inch meridian-circle has just been finished for the observatory of the Catholic University of America (Professor SEARLE); and that a photographic equatorial, a combined transit and zenith telescope, position-micrometer, and a chronograph are now in hand for Cordoba, Argentine Republic, (Dr. THOME). The observatory of Notre Dame College, at South Bend, Indiana, has ordered a seven-inch equatorial, a transit, a clock, and a chronograph; and four other equatorials are in process of construction (apertures, five to nine inches). E. S. H.

REQUEST TO ASTRONOMERS REGARDING EPHEMERIDES OF COMETS, ETC.

The *Astronomische Nachrichten* and other European journals are received at Mount Hamilton from twenty days to a month after their dates of publication, and we frequently find that the ephemerides of comets, etc., as printed, have expired when the journal reaches us. Computers will confer a great favor upon the LICK Observatory if they will remember this delay of twenty to thirty days in printing their ephemerides, or if they will kindly send a *ms.* ephemeris by letter. It is not always possible for us to spare the time to extend an ephemeris. The orbits of comets

discovered at Mount Hamilton are always calculated here, but for other comets we must depend, in general, upon orbits and ephemerides computed elsewhere. EDWARD S. HOLDEN.

1896, January 4.

NEW EDITION (1895) OF PROFESSOR YOUNG'S BOOK ON THE SUN.

The publishers of the International Scientific Series have issued a new and revised edition of Professor YOUNG'S book on the *Sun*, which will be, like its predecessor, indispensable in every astronomical library. E. S. H.

PROGRESS OF THE ASTRONOMICAL SOCIETY OF FRANCE.

The number of members of the Society at the end of each calendar year is given in the table following:

1887,	90 members.	1891,	455 members.
1888,	188 "	1892,	552 "
1889,	288 "	1893,	640 "
1890,	366 "	1894,	742 "

1895, 1133 members.

The Society is to be congratulated, not only upon its rapid growth, but upon the excellent journal which it issues monthly, the *Bulletin de la Société Astronomique de France*, an octavo of more than 400 pages, well illustrated. E. S. H.

NOMENCLATURE OF THE ASTEROIDS, ETC.

It may be interesting to recall a bit of ancient history with regard to the nomenclature of the asteroids, though it is entirely too late to hope for a reform. In the *Astronomical Journal*, vol. i., p. 134 (1850), Dr. GOULD, the editor, has a note upon the discovery of a new planet by HIND. "Mr. HIND has selected the name *Victoria*, with a star surrounded by a laurel wreath for a symbol. Such nomenclature is at variance with established usage," Dr. GOULD goes on to say, "and is liable to the objections which very properly led astronomers to reject the names *Medicean Stars*, *Georgium Sidus*, *Ceres Ferdinandea*, etc., and even those of the astronomers HERSCHEL and LEVERRIER, for the adoption of whose names some arguments might be adduced." In the same volume of the *Journal* (page 139), Mr. W. C. BOND, Director of Harvard College Observatory, writes on the same

subject, that "*Victoria* was the daughter of *Pallas*, and one of the attendants of *Jupiter*, and, therefore, the name appears to fulfill the required conditions of a mythological nomenclature." On this Dr. GOULD has a note to the effect that the *Pallas* in question was a "a giant—not the goddess, who is believed to have left no children." In the same volume of the *Journal* (page 151) Mr. HIND prints a letter saying that "the name *Victoria* was submitted to the approbation of astronomers on mythological grounds, and not exclusively as marking the country where the discovery was made. I foresaw the objections which you have advanced, and, therefore, devised a symbol which would apply equally well to *Victoria* or to another name,—*Clio*,—which I had in view in case the general feeling of astronomers was against the latter. . . . I would at once reject any name that is not found in mythology." With this letter the incident ended; the name *Victoria* was, however, adopted, but the rule of choosing a mythological name for newly discovered bodies was apparently more firmly settled than ever. *Victoria* was such a name. There can be no doubt that the rule is a good one.

The Comet IV of 1857 was discovered by Dr. C. H. F. PETERS, at the DUDLEY Observatory, Albany, and was named by him the "OLCOTT-Comet," after one of the trustees. This name was not accepted by the *Journal*, nor by astronomers generally, any more than the name "Comet-TEWFIK," given to the comet discovered at the Egyptian eclipse of 1882 in the presence of the Khedive TEWFIK. The absurdity to which such personal names will lead is well illustrated by an English chart of the Moon, on which one of the craters bears the name "Mrs. JACKSON-GWILT." Several charts of *Mars* also are burdened with personal names, but the elegant and scholarly nomenclature of SCHIAPARELLI'S map, where the names are from ancient geography and history, will undoubtedly prevail.

To return to the asteroids. About 1852, the minor-planets began to be found in such numbers that the invention of separate symbols for them was abandoned, and they were designated by numbers, which signified the order of their discovery, enclosed in circles. Thus, *Victoria* now has for a symbol, (12). The *names* of the planetoids continued to be chosen from mythology. (67) = *Asia* was discovered by POGSON in Madras. She was one of the *Oceanides*, the wife of *Iapetus* and the mother of *Atlas* and *Prometheus*. The name was thus at once conventionally correct and

happily chosen. No one was more happy in choosing such names, in general, than Dr. PETERS, who discovered so many of these bodies. Immediately after returning from the Transit of *Venus* expedition, he discovered two planets,—*Adeona* and *Vibilia*,—in one night. *Adeona* is the patroness of home-coming, and *Vibilia* the patroness of ways—of journeyings. The name of his asteroid *Miriam* (who was the sister of *Moses*) was chosen in defiance of rule, and of malice aforethought; so that he could tell a theological professor, whom he thought to be too pious, that *Miriam*, also, was "a mythological personage."

Juewa, discovered by WATSON in China in 1874, is out of Chinese mythology; and *Freia* (D'ARREST, 1862) and *Frigga* (PETERS, 1862) from Scandinavian. I do not find *Polana* (discovered by PALISA at Pola in 1875) in any mythology, and she probably is an invented patroness of her city, Pola. *Gallia* (HENRY, at Paris, 1875.) is an evident departure from the strict rule. From about this time onward such departures are frequent. *Hilda*, *Bertha*, *Eva*, *Irma*, *Elsa*, *Lamberta*, *Martha*, *Isabella*, *Bianca*, *Stephania*, *Lucia*, *Rosa*, *Henrietta*, *Barbara*, *Carolina*, *Ida*, *Bettina*, *Clementina*, *Mathilde*, *Augusta*, *Huberta*, *Anna*, *Aline*, *Antonia*, *Elvira*, *Paulina*, *Lucretia*,* *Clorinda*, *Emma*, *Amelia*, *Alice*, *Baptistine*, *Geraldine*, *Dorothea*, *Clarissa*, *Olga*, *Gordonia*, *Margarita*, *Goberta*, *Katharina*, *Chicago*, etc., (all adopted names of asteroids), may, some of them, have a right in a list of heavenly bodies, but many of them, at least, read like the Christian names in a girls' school.

No doubt the departure from a strictly classical nomenclature has gone too far to be corrected now, but there is no question the departure is, on the whole, to be regretted; and, although the matter of nomenclature is a minor one, it is worth while to keep it as impersonal as possible in the future. The abuses to which a contrary course might lead are only too evident.

E. S. H.

LICK OBSERVATORY EXPEDITION TO OBSERVE THE TOTAL SOLAR ECLIPSE OF AUGUST, 1896, IN JAPAN.

An expedition to observe the total solar eclipse of August, 1896, will be sent from the LICK Observatory, under the direction of Professor J. M. SCHAEBERLE. The expedition has been

* Named in honor of LUCRETIA CAROLINE HERSCHEL.

authorized by the Regents of the University, and its expenses will be met from a fund generously offered by Colonel C. F. CROCKER, a member of the Regents' Committee on the LICK Observatory.*

The programme of the expedition will be wholly photographic. Professor SCHAEBERLE will make large-scale photographs of the corona with a lens of forty-foot focus, on the plan which was so successful in Chile in 1893; and smaller scale pictures (some on standardized plates) will be taken with the five-inch FLOYD photographic telescope.

Mr. BURCKHALTER, Director of the Chabot Observatory, Oakland, will photograph the corona on a plan described by him in these *Publications*, Vol. VII, 1896, page 157, with a special photographic telescope, of four inches aperture and twenty feet focus (provided at the expense of Hon. WILLIAM M. PIERSON, of San Francisco). A portion of Mr. BURCKHALTER'S apparatus is provided by a gift from Mrs. PHŒBE HEARST.

Dr. G. E. SHUEY and Mr. LOUIS C. MASTEN have volunteered to accompany the expedition (at their own cost), to serve as assistants to Professor SCHAEBERLE and Mr. BURCKHALTER, and to manage the smaller instruments. Professor H. TERAO, Director of the Imperial Observatory of Tokyo, has kindly offered to select a member of the staff of his observatory to accompany the LICK Observatory Expedition, as one of its members, to its station in Japan.

It is to be hoped that the expedition may meet with good weather, and return with results which will reward its efforts.

E. S. H.

MOUNT HAMILTON, January 17, 1896.

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* It will be remembered that the LICK Observatory Eclipse Expedition to Cayenne in December, 1889, was also sent at the expense of Colonel CROCKER.

Minutes of the Meeting of the Board of Directors, held in the Rooms of the Society, January 25, 1896, at 7:30 P. M.

President BURCKHALTER presided. A quorum was present. The minutes of the last meeting were approved. The following members were duly elected:

List of Members Elected January 25, 1896.

Mr. GEORGE V. HICKS	532 California St., S. F., Cal.
Mr. BEVERLY LETCHER	532 California St., S. F., Cal.
Mrs. F. K. UPHAM	National Soldiers' Home, Los Angeles Co., Cal.
Library of the CHABOT Observatory	Oakland, Cal.
Library of the College of New Jersey	Princeton, New Jersey.
Library of the LICK Observatory	Mount Hamilton, Cal.
Library of the LELAND STANFORD JR. University	Stanford University, Cal.

Mr. C. A. SPRECKELS and Mrs. C. A. SPRECKELS were elected to life membership.

On motion, the following resolutions were adopted:

WHEREAS, The LICK Observatory, the CHABOT Observatory, and the LELAND STANFORD JR. University have become members of the Society, to date from January 1, 1896;

Resolved, That these names be transferred from the list of corresponding institutions to the list of active members.

Resolved, That, on the recommendation of the Committee on Publication, the edition of the *Publications* be fixed at 750 copies, for the present.

Resolved, That the funds belonging to the General Fund of the Society be deposited with the DONOHOE-KELLY Banking Company, and with the Security Savings Bank, as provided in the resolution adopted December 29, 1892.

Adjourned.

Minutes of the Meeting of the Astronomical Society of the Pacific, held in the Lecture Hall of the California Academy of Sciences, January 25, 1896.

The meeting was called to order by President BURCKHALTER. The minutes of the last meeting were approved.

The Secretary read the names of new members duly elected at the Directors' meeting.

The resolutions adopted at the Directors' meeting were read and approved.

A committee to nominate a list of eleven Directors and Committee on Publication, to be voted for at the annual meeting, to be held on March 28th, was appointed, as follows: Messrs. C. M. St. John (Chairman), Chas. S. Cushing, D. S. Richardson, J. Costa, and George W. Percy.

A committee to audit the accounts of the Treasurer, and to report at the annual meeting, was appointed, as follows: Messrs. D. F. Tillinghast (Chairman), Chas. B. Hill, and Louis C. Masten.

The following papers were presented:

1. On the grinding of a silver on glass Reflector, illustrated by a mirror under construction, by Mr. Allen H. Babcock.
2. The orbit of Comet Perrine, illustrated by lantern-slides, by Mr. Chas. B. Hill.
3. A new method of photographing the Corona, illustrated by the apparatus, by Mr. Charles Burckhalter.
4. Weather Forecasting: its present methods, limitations, and future possibilities, with lantern-slide illustrations, by Mr. W. H. Hammon, Forecast official U. S. Weather Bureau.

These papers were read by the authors.

Secretary Ziel exhibited a slide representing the sky at the time of totality of the eclipse of August 9, 1896, showing the relative positions of the planets *Jupiter*, *Venus*, and *Mercury*, and the brighter fixed stars.

The thanks of the Society were returned to the California Academy of Sciences for the use of the lecture hall.

Adjourned.

OFFICERS OF THE SOCIETY.

CHAS. BURCKHALTER (CHABOT Observatory, Oakland), ... *President*

W. J. HUSSEY (LICK Observatory),
E. S. HOLDEN (LICK Observatory)
O. VON GELDERN (819 Market Street, S. F.), } . . . . . . *Vice-Presidents*

C. D. PERRINE (LICK Observatory), ... *Secretary*

F. R. ZIEL (410 California Street, S. F.), ... *Secretary and Treasurer*

Board of Directors—Messrs. BURCKHALTER, HOLDEN, HUSSEY, MOLERA, Miss O'HALLORAN, Messrs. PERRINE, PIERSON, SCHAEBERLE, STRINGHAM, VON GELDERN, ZIEL.

Finance Committee—Messrs. VON GELDERN, PIERSON, STRINGHAM.

Committee on Publication—Messrs. HOLDEN, CAMPBELL, BABCOCK.

Library Committee—Mr. MOLERA, Miss O'HALLORAN, Mr. BABCOCK.

Committee on the Comet-Medal—Messrs. HOLDEN (*ex-officio*), SCHAEBERLE, HUSSEY.

OFFICERS OF THE CHICAGO SECTION.

Executive Committee—Mr. RUTHVEN W. PIKE.

OFFICERS OF THE MEXICAN SECTION.

Executive Committee—Messrs. CAMILO GONZALEZ, FRANCISCO RODRIGUEZ REY.

NOTICE.

The attention of new members is called to Article VIII of the By-Laws, which provides that the annual subscription, paid on election, covers the *calendar* year only Subsequent annual payments are due on January 1st of each succeeding calendar year. This rule is necessary in order to make our book-keeping as simple as possible. Dues sent by mail should be directed to Astronomical Society of the Pacific 819 Market Street, San Francisco.

It is intended that each member of the Society shall receive a copy of each one of the *Publications* for the year in which he was elected to membership and for all subsequent years. If there have been (unfortunately) any omissions in this matter, it is requested that the Secretaries be at once notified, in order that the missing numbers may be supplied. Members are requested to preserve the copies of the *Publications* of the Society as sent to them. Once each year a title-page and contents of the preceding numbers will also be sent to the members, who can then bind the numbers together into a volume. Complete volumes for past years will also be supplied, to members only, so far as the stock in hand is sufficient, on the payment of two dollars to either of the Secretaries. Any non-resident member within the United States can obtain books from the Society's library by sending his library card with ten cents in stamps to the Secretary A. S. P., 819 Market Street, San Francisco, who will return the book and the card.

The Committee on Publication desires to say that the order in which papers are printed in the *Publications* is decided simply by convenience. In a general way, those papers are printed first which are earliest accepted for publication. It is not possible to send proof sheets of papers to be printed to authors whose residence is not within the United States. The responsibility for the views expressed in the papers printed rests with the writers, and is not assumed by the Society itself.

The titles of papers for reading should be communicated to either of the Secretaries as early as possible, as well as any changes in addresses. The Secretary in San Francisco will send to any member of the Society suitable stationery, stamped with the seal of the Society, at cost price, as follows: a block of letter paper, 40 cents; of note paper, 25 cents; a package of envelopes, 25 cents. These prices include postage, and should be remitted by money-order or in U. S. postage stamps. The sendings are at the risk of the member.

Those members who propose to attend the meetings at Mount Hamilton during the summer should communicate with "The Secretary Astronomical Society of the Pacific" at the rooms of the Society, 819 Market Street, San Francisco, in order that arrangements may be made for transportation, lodging, etc.

PUBLICATIONS ISSUED BI-MONTHLY.

(February, April, June, August, October, December.)

LICK OBSERVATORY IN WINTER.
(From a Negative by MR. C. D. PERRINE.)

PUBLICATIONS

Astronomical Society of the Pacific.

VOL. VIII. SAN FRANCISCO, CALIFORNIA, APRIL 1, 1896. NO. 48.

ADDRESS OF THE RETIRING PRESIDENT OF THE SOCIETY, AT THE EIGHTH ANNUAL MEETING, MARCH 28, 1896.

BY CHAS. BURCKHALTER.

LADIES AND GENTLEMEN:—Following the custom of my predecessors retiring from this chair, I briefly submit for your consideration a few thoughts on the condition, progress, and aims of our Society. The Astronomical Society of the Pacific, with this meeting, has reached the age of seven years, and at no time has it been as strong in ability or a more potent factor in astronomy. With the same conservative management in the future that has characterized the past, this influence will grow and expand.

The fortunate occurrence, almost at our doors, of a total solar eclipse, gave the Society birth. The eclipse of New Year's Day, 1889, brought out and together the active and latent astronomical talent of this city and surrounding towns, and laid the foundation of our Society, and resulted in a united, intelligent and successful effort to add to our knowledge of the science, by the work of local amateurs and their friends. The Director of the LICK Observatory saw an opportunity of making this somewhat indiscriminate coming together of amateur photographers and astronomers the basis of a permanent organization. The first call resulted in a preliminary meeting in the rooms of the Pacific Coast Amateur Photographic Association, on February 7, 1889, and the first regular meeting, held in the March following, witnessed the formal organization of our Society, *sans* everything but boundless enthusiasm.

The remarkable growth of the Society surprised its most enthusiastic friends, attracting attention everywhere, and was proof, if proof was needed, that a popular society of professional and amateur astronomers could flourish in this comparatively new community. Every meeting added new names to our roll of membership. Names from the Eastern States and foreign countries became surprisingly numerous, and the rapid growth of the Society added unexpected labor to the few who did most of the hard work incident to organization, and required your officers to give more and more of their time to the increasing wants and interests of the Society. For the most part, these same men are still bearing the heat and burden of the day, with no thought of reward but the justly deserved "Well done, good and faithful servant."

I do not believe the Society, as a body, has ever fully realized how much has been done by the few. Composed as it is of a widely scattered membership, it has devolved (and always will fall) upon a few to carry on the work. This wide distribution of our members has the disadvantage that the work cannot well be divided; but, on the other hand, the sphere of the Society's influence is correspondingly increased, and the bringing together of such widely scattered and disassociated forces can result only in good for astronomy.

I desire to call the attention of those of us who have the advantages of the San Francisco meetings, the opportunity of meeting twice each year at our great LICK Observatory, and the use of our fine library, to the fact that the non-resident members of the Society receive in return for their subscriptions only the publications of the Society. Our non-resident membership, a very large percentage of the whole, will wax and wane as our publications appreciate or depreciate in value. Every effort must be made to increase our volumes in number and size, and this again depends almost entirely upon the amount of funds that we can place in the hands of the Publication Committee. It is especially important to provide for well-chosen and instructive illustrations. It is the custom of the retiring President to advise the members of the Society's needs, he, presumably, being familiar with its wants and conditions. If I am to follow this well-established rule, I will concentrate all my energies in one sentence, and say, that in my opinion the greatest need of the Society to-day is, *more money for the publications.* Our Publica-

tion Committee has worked faithfully and given us full return for all that we have given them. Rigid economy has been practiced in every department in favor of the publications, thus returning to our non-resident members nearly all they gave. The publications are first-class in every respect, and, to show that I am not alone in this opinion, I will take the liberty of quoting from a private letter of the Director of an American Observatory the following appreciative sentences:

"I wish to tell you something which you may perhaps know already. The publications of the *A. S. P.* contain the best digest of what is going on in the astronomical world to be found.

"Prior to revising some book manuscripts, I have just been reading up the doings of astronomers during the past two years. In the *A. S. P.* I found practically everything that I found elsewhere which was of service to me."

If this compliment is deserved, and I believe it is, it should result in greater efforts than we have yet made, to increase the value of this branch of the Society's work.

When stating a need it should, if possible, carry with it the remedy, and this is very simple, indeed,—more members! I have no doubt that many of our members have often wished they could do some service to the Society and astronomy. Because they cannot discover more *Neptunes*, or write valuable papers for the meetings, they persuade themselves that they can do little of value; and end by doing nothing. I will, therefore, venture to point out a most excellent way, within the power of every member, of advancing the cause of science on our coast, and greatly helping our Society; which is nothing more than to add new names to our list of members.

The Society is open to both gentlemen and ladies. We require no exhaustive knowledge of astronomy, or deeply studied thesis, but only an honest love for Urania, and an earnest desire to promote the study of the science and the diffusion of our knowledge covering it. As most of our expenses are fixed, each new member means so much additional for enhancing the value of our publications, and more widely sowing the good seed.

I will venture to offer another suggestion, intended for our local members. You have been, in the past, entirely too modest in reading papers before the Society, and in discussing those read. Because you believe you cannot prepare papers that will arrest the attention of the astronomical world in high places, is no

reason why you should not prepare papers for our meetings. They need not, necessarily, be published, and you may feel confident that anything that will interest you will interest a majority of the members who attend the meetings, and it should be borne in mind that many members are only in the A B C of astronomy, and papers read by those not far advanced are more likely to be understood, and therefore more often useful, than the finished paper of the professional astronomer. The object of the meetings is to instruct each other, rather than to attract the attention of astronomers. This is a Society of amateurs and professionals, not a Society of experts alone. As a Society, we have been remarkably fortunate in receiving generous gifts from some of our members, while the LICK Observatory, which is our foundation-stone, has received gifts worthy of princes from others. I need only mention ALEXANDER MONTGOMERY, who founded and endowed our library, and JOSEPH A. DONOHOE, who founded and endowed the Comet-Medal.

At the present time, preparations are being made by the LICK Observatory to send an eclipse expedition of four members to Japan, to observe the eclipse of August 9th, under the direction of Professor SCHAEBERLE, at the expense of Colonel C. F. CROCKER. Ex-President WM. M. PIERSON generously furnished the funds to equip one of the members with an expensive and novel telescope for this special work, while Mrs. PHŒBE HEARST has given liberally to carry on the necessary experiments to investigate the possibilities of this novelty, and I take pride in saying that every one of the members of the expedition, and all the generous contributors, are our fellow-members.

In conclusion, I congratulate you upon the successful work accomplished in our short history and the wide-spreading influence of the Society. At this time, when astronomy is making such startling progress, and its popular study is so wonderfully increasing, one of the greatest results we can achieve for its advancement is to induce others to share our privileges, and to bring them within the unseen yet powerful influence that unity of thought and purpose alone can give.

PLANETARY PHENOMENA FOR MAY AND JUNE, 1896.

By Professor Malcolm McNeill.

May, 1896.

Mercury is an evening star throughout the month, coming to its greatest eastern elongation, 22° 9′, on May 16; during the entire month it remains above the horizon more than an hour after sunset, and about the middle of the month nearly two hours. This is the best time of the year for seeing it as an evening star. The distance from the Sun is not as great as it was during the preceding greatest west elongation, but during the greater part of the month the planet is several degrees north of the Sun, and this retards its setting quite a number of minutes. It moves rapidly eastward in the constellation *Taurus*. On May 9th it passes eight degrees north of the first-magnitude star α *Tauri*, and on May 19th it passes three degrees south of the second-magnitude star β *Tauri*. Toward the close of the month, the distance between planet and Sun diminishes rapidly.

Venus is still a morning star, but it is so near the Sun that it is no longer conspicuous, rising only about half an hour before the Sun at the close of the month. It moves eastward and northward among the stars from *Pisces*, through *Aries*, into *Taurus*, and on May 31st is about four degrees south of the *Pleiades*.

Mars is slowly creeping away from the Sun, and rises a little earlier than before. It is continually coming nearer to us and gaining in brightness, but the change is very slow, and it will not be as near to us as is the Sun until September. Its apparent motion among the stars is east and north, about twenty-five degrees in the constellation *Pisces*.

Jupiter is still the most prominent object in the western sky in the evening, and sets about two hours earlier than it did during April. It moves about five degrees east and south in the constellation *Cancer*.

Saturn is getting into very good position for observation. On May 1st it rises just a little after sunset, and is above the horizon practically the entire night. It comes to opposition on the afternoon of May 5th. It is retrograding (moving westward)

in the constellation *Libra*, and moves toward its brightest star, α *Libræ*. The rings are apparently not as wide open as in March, owing to the change in our position with reference to their plane, due to the earth's orbital motion around the Sun. This closing up is only a trifle, about two per cent., and lasts only a few months. The general change in the appearance of the rings is a progressive increase in size of minor axis, until the maximum is reached in 1898, but there are periods of slight retrogression near each opposition.

Uranus is in the same neighborhood as *Saturn*, and comes into opposition on May 12. It moves slowly west in the constellation *Libra*, and is about halfway between α *Libræ* and β *Scorpii*.

Neptune is in the eastern part of *Taurus*, and sets very soon after the sun.

JUNE, 1896.

The Sun reaches the summer solstice, and summer begins on the afternoon of June 20th, about 2 P.M., P. S. T.

Mercury is an evening star, setting about an hour after the Sun on June 1st, rather too near to be easily seen, except under very favorable conditions of weather. It rapidly nears the Sun, passing inferior conjunction on June 8th, and becomes a morning star. It then moves rapidly away from the Sun, and by the close of the month is nearly out to the greatest west elongation, rising about an hour and a quarter before the Sun.

Venus is still a morning star, but is too close to the Sun to be easily seen. At the close of the month, it rises only a quarter of an hour before sunrise.

Mars is moving away from the Sun and rising earlier, before 1 A.M. on June 30th. It moves about twenty-three degrees east and north from *Pisces* into *Aries*, and is a trifle brighter than it was during May. It is in perihelion on the morning of June 12th. It is then about 128,000,000 miles distant from the Sun. Its distance from the Earth is about 10,000,000 miles more.

Jupiter is still conspicuous in the western sky, but is drawing too near the Sun for good telescopic observation. At the close of the month it sets at a little after 9 P.M. It moves about six degrees east and a little south in the constellation *Cancer*. On the afternoon of June 14th it is very close to the Moon, and in some places there will be an occultation, but the time of

nearest approach occurs during daylight for most of the United States.

Saturn is in excellent position for observation, being well above the horizon at sunset and not setting until long after midnight. It moves about one degree westward in the constellation *Libra*, and during the latter part of the month is very close to the brightest star of the constellation, the third-magnitude α *Libræ*. The nearest approach is on June 19th, when the planet passes about two degrees north of the star.

Uranus follows *Saturn* about eight degrees east and four degrees south, and lies about halfway between it and β *Scorpii*.

Neptune is very close to the Sun, passing conjunction and changing from an evening to a morning star on the evening of June 7th.

Explanation of the Tables.

The phases of the Moon are given in Pacific Standard time. In the tables for Sun and planets, the second and third columns give the Right Ascension and Declination for Greenwich noon. The fifth column gives the local mean time for transit over the Greenwich meridian. To find the local mean time of transit for any other meridian, the time given in the table must be corrected by adding or subtracting the change per day, multiplied by the fraction whose numerator is the longitude from Greenwich in hours, and whose denominator is 24. This correction is seldom much more than 1^m. To find the standard time for the phenomenon, correct the local mean time by *adding* the difference between standard and local time if the place is west of the standard meridian, and *subtracting* if east. The same rules apply to the fourth and sixth columns, which give the local mean times of rising and setting for the meridian of Greenwich. They are roughly computed for Lat. 40°, with the noon Declination and time of meridian transit, and are intended as only a rough guide. They may be in error by a minute or two for the given latitude, and for latitudes differing much from 40° they may be several minutes out.

Phases of the Moon, P. S. T.

		H. M.
Last Quarter,	May 4,	7 25 A. M.
New Moon,	May 12,	11 47 A. M.
First Quarter,	May 19,	10 21 P. M.
Full Moon,	May 26,	1 56 P. M.

The Sun.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
May 1.	2 37	+15 19	5 4 A.M.	11 57 A.M.	6 50 P.M.
11.	3 15	+18 5	4 53	11 56	6 59
21.	3 55	+20 21	4 44	11 56	7 8
31.	4 35	+22 1	4 39	11 58	7 18

Mercury.

May 1.	3 34	+20 58	5 39 A.M.	12 54 P.M.	8 9 P.M.
11.	4 42	+24 44	5 52	1 23	8 54
21.	5 25	+24 57	5 55	1 27	8 59
31.	5 35	+22 52	5 34	12 57	8 20

Venus.

May 1.	1 28	+ 7 35	4 22 A.M.	10 48 A.M.	5 14 P.M.
11.	2 14	+12 3	4 14	10 55	5 36
21.	3 2	+16 3	4 7	11 3	5 59
31.	3 51	+19 24	4 4	11 13	6 22

Mars.

May 1.	23 6	− 7 24	2 52 A.M.	8 27 A.M.	2 2 P.M.
11.	23 34	− 4 31	2 30	8 15	2 0
21.	0 2	− 1 34	2 9	8 4	1 59
31.	0 30	+ 1 21	1 47	7 52	1 57

Jupiter.

May 1.	8 14	+20 35	10 21 A.M.	5 34 P.M.	12 47 A.M.
11.	8 19	+20 19	9 48	5 0	12 12
21.	8 25	+19 59	9 15	4 26	11 37 P.M.
31.	8 32	+19 36	8 44	3 53	11 2

Saturn.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
May 1.	14 58	− 14 14	7 9 P.M.	12 20 A.M.	5 31 A.M.
11.	14 55	− 14 1	6 22	11 34 P.M.	4 46
21.	14 52	− 13 49	5 38	10 51	4 4
31.	14 49	− 13 39	4 56	10 9	3 23

Uranus.

May 1.	15 23	− 18 15	7 49 P.M.	12 45 A.M.	5 41 A.M.
11.	15 21	− 18 8	7 7	12 4	5 1
21.	15 19	− 18 2	6 22	11 19 P.M.	4 16
31.	15 17	− 17 56	5 41	10 38	3 35

Neptune.

May 1.	5 2	+ 21 23	7 6 A.M.	2 22 P.M.	9 40 P.M.
11.	5 3	+ 21 25	6 26	1 43	9 0
21.	5 5	+ 21 27	5 49	1 6	8 23
31.	5 6	+ 21 30	5 11	12 28	7 45

Eclipses of *Jupiter's* Satellites, P. S. T.

(Off right-hand limb, as seen in an inverting telescope.)

		H. M.			H. M.
II, R,	May 1.	6 50 P. M.	III, D,	May 15.	8 8 P. M.
I, R,	2.	5 24 P. M.	III, R,	15.	11 42 P. M.
III, R,	8.	7 42 P. M.	I, R,	16.	9 15 P. M.
II, R,	8.	9 25 P. M.	I, R,	23.	11 10 P. M.
I, R,	9.	7 19 P. M.	I, R,	25.	5 39 P. M.

Phases of the Moon, P. S. T.

		H. M.
Last Quarter,	June 3,	12 2 A. M.
New Moon,	June 11,	12 43 A. M.
First Quarter,	June 18,	3 41 A. M.
Full Moon,	June 24,	10 55 P. M.

The Sun.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
June 1.	4 40	+ 22 10	4 38 A.M.	11 58 A.M.	7 18 P.M.
11.	5 21	+ 23 9	4 35	11 59	7 23
21.	6 2	+ 23 27	4 37	12 2 P.M.	7 27
July 1.	6 44	+ 23 4	4 41	12 4	7 27

Mercury.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
June 1.	5 35	+23 34	5 57 A.M.	12 53 P.M.	8 19 P.M.
11.	5 16	+19 37	4 46	11 55 A.M.	7 4
21.	5 1	+18 15	3 56	11 0	6 4
July 1.	5 14	+19 31	3 25	10 34	5 43

Venus.

June 1.	3 56	+19 41	4 4 A.M.	11 14 A.M.	6 24 P.M.
11.	4 48	+22 5	4 7	11 26	6 45
21.	5 41	+23 27	4 15	11 40	7 5
July 1.	6 34	+23 41	4 27	11 54	7 21

Mars.

June 1.	0 32	+ 1 38	1 45 A.M.	7 50 A.M.	1 55 P.M.
11.	0 59	+ 4 30	1 23	7 38	1 53
21.	1 26	+ 7 14	1 1	7 26	1 51
July 1.	1 53	+ 9 50	12 40	7 14	1 48

Jupiter.

June 1.	8 32	+19 34	8 41 A.M.	3 50 P.M.	10 59 P.M.
11.	8 39	+19 7	8 11	3 18	10 25
21.	8 47	+18 38	7 41	2 46	9 51
July 1.	8 55	+18 6	7 12	2 15	9 18

Saturn.

June 1.	14 49	−13 38	4 52 P.M.	10 5 P.M.	3 18 A.M.
11.	14 47	−13 29	4 10	9 24	2 38
21.	14 45	−13 23	3 29	8 43	1 57
July 1.	14 44	−13 20	2 48	8 2	1 16

Uranus.

June 1.	15 18	−17 56	5 37 P.M.	10 34 P.M.	3 31 A.M.
11.	15 16	−17 50	4 55	9 53	2 51
21.	15 15	−17 45	4 14	9 12	2 10
July 1.	15 14	−17 41	3 34	8 32	1 30

Neptune.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
June 1.	5 6	+21 30	5 7 A.M.	12 24 P.M.	7 41 P.M.
11.	5 8	+21 32	4 30	11 47 A.M.	7 4
21.	5 9	+21 34	3 52	11 9	6 26
July 1.	5 11	+21 36	3 14	10 31	5 48

Eclipses of *Jupiter's* Satellites, P. S. T.

(Off right-hand limb, as seen in an inverting telescope.)

	H. M.		H. M.
I, R, June 1.	7 35 P. M.	II, R, June 9.	9 0 P. M.
IV, D, 2.	6 6 P. M.	I, R, 17.	5 53 P. M.
II, R, 2.	6 26 P. M.	IV, R, 19.	4 55 P. M.
IV, R, 2.	10 52 P. M.	III, R, 20.	7 42 P. M.
I, R, 8.	9 29 P. M.	I, R, 24.	7 48 P. M.

SOME LARGE PERTURBATIONS IN THE MOTIONS OF CELESTIAL BODIES.*

The novice in astronomy often believes that the motions of planets and satellites take place with great regularity, according to KEPLER'S laws, and that the disturbances caused by their reactions upon each other are only slight. A closer investigation shows, however, that the "harmony of the universe" is often seriously disturbed. In seeking for the reasons of these phenomena, the mathematical theory of planetary motions has been materially furthered, and convincing proof has been furnished that its foundation,—*i. e.*, NEWTON'S law of attraction,—is correct. Although one of these disturbances was already known in the early stages of the planetary theory, yet such great mathematicians as LAGRANGE and EULER could not give a sufficient explanation of it. We refer to the motions of *Jupiter* and *Saturn*, in which great deviations were discovered, increasing with the time.

It remained for LAPLACE, the real founder of celestial mechanics, to discover the reason, namely; that the times of revo-

*From the January number, 1896, of *Himmel und Erde*. Translated for the Society by Mr. C. A. STETEFELDT.

lution of the two planets stand very nearly in the relation of two to five. Deviations are thereby produced which, returning only after 900 years in the same order, become so summed up that the simple motions in the ideal elliptic orbits are completely destroyed. Similar phenomena occur wherever two celestial bodies, moving round the same main body, have times of revolution standing in a simple relation to each other. The greater the inclination of such orbits, and the more pronounced their elliptic eccentricity, the more marked, necessarily, are the deviations. It may even occur that the body cannot be observed for a long time, because we look for it at a place considerably removed from its actual position. As an example, the planet *Andromache* may be mentioned. Its time of revolution stands to that of *Jupiter* nearly in the relation of four to nine. It is evident that the movements of this small planet, having an orbit of great eccentricity, must be seriously disturbed by the giant *Jupiter*. These disturbances act for about 200 years in the same direction, and only after the expiration of this period in an opposite one. In consequence, the planet was actually lost to observation, and restored only by celestial photography. BERBERICH proved that in the mean time strange changes, reaching enormous figures, had taken place in its orbital elements.*

Satellites present an example of disturbances of a different kind. Of the eight satellites of *Saturn*, the sixth (*Titan*), and the seventh (*Hyperion*), are so connected that three revolutions of the latter require the same time as four of the former. Considering that the orbit of *Hyperion* deviates considerably from a circle (the focal points of the ellipse are distant from the center one-eighth of the major semi-axis), it follows that the two satellites must disturb each other considerably. *Titan*, discovered by HUYGHENS, the brightest of *Saturn's* moons, has been observed longest, and its orbit is well known through BESSEL'S measurements and calculations. *Hyperion* is the faintest of these moonlets, and was discovered in 1848 by BOND and LASSELL. Since then it has been accurately observed by HALL, in Washington, and by H. STRUVE, in Pulkowa, through their giant telescopes. According to HALL and STRUVE, the rapid retrograde movement of the major axis of the elliptic orbit is nearly 20° in one year.

* Nat. Rdsch. 189.

† With our Moon, the corresponding turning of the elliptic orbit is twice as much; but in this instance, it is the result of solar attraction, which is considerably greater than that of the Earth. In the case of *Hyperion*, it is produced by the attraction of another moonlet.

The theory of this body is, however, as yet so incomplete that the Paris Academy has announced a prize for a satisfactory theory. Such a theory also presupposes the determination of *Titan's* mass. On the other hand, a comparison of the theory with observations would give a determination of the mass. Thus, the mass of *Saturn* could be deduced with tolerable accuracy from the disturbances in *Jupiter's* orbit. In *Titan's* orbit similar deviations may be found, which, however, on account of the slight mass of *Hyperion*, must be less prominent than the disturbances of the latter. From these, nevertheless, the mass of even such a small body could be determined with some accuracy.

THE CIRCULATION OF THE ATMOSPHERE OF PLANETS.

By Marsden Manson, Ph. D.

Our knowledge of the circulation of the atmosphere of planets has been so befogged by detail, that the grand and simple principles involved are lost in the maze of irrelevant and incompetent data which has been woven about the subject.*

The problem is intricate when attacked solely from the standpoint of the meteorologist, and it is doubtful whether an explanation of the prime mode of action of solar energy in producing atmospheric circulation has place in any treatise or text upon the subject. It is certain that none of the laws and formulæ laid down in meteorology will explain the grandeur and the delicate balance of the movements observed in the atmosphere of *Jupiter*. Nor will these complicated and empirical rules explain the

* The writer was led into making this investigation in a very peculiar manner, and it may not be inappropriate to outline the facts.

The amounts and distribution of rainfall upon the Pacific Coast became a subject of interest to the writer in 1877. This limited study broadened into a general one of the state of meteorology. Repeated failures to grasp the scope of the fundamental facts and laws, through these sources of knowledge, led into the general question as to whether the interpretations of meteorology would, in their simplest form, explain the movements observed upon *Jupiter*.

The view was entertained that the fundamental laws of the circulation of the atmosphere were true for all planets.

An apology is also due for the crudeness of the form in which these studies are presented — for their preparation has been confined to the moments which can be snatched from bread-winning in other lines.

apparently complex and confusing movements of the Krakatoa dust cloud, which, in 1883, gave such splendid opportunities to observe atmospheric movements.

Even the distinguished committee appointed by the Royal Society to investigate the phenomena attendant upon the Krakatoa explosion were forced, under present views, to partly attribute the movements of that cloud to "other laws than those which regulate the motion of the air in which it floated." The truth of the matter is, that the dust cloud floated in exact accordance with the laws which regulate the movement of the atmospheres of planets; but the laws heretofore given are the empirical laws of man, and not the interpreted laws of nature.

It is therefore necessary to develop the prime mode of action of solar energy in producing atmospheric circulation upon the globe, and to apply the same reasoning and methods to elucidate the movements in the Jovian cloud system.

It is a known fact, established by many extended series of observations, that the barometer has, at all latitudes, a daily variation caused by the action of solar energy. This rise and fall is greatest in the torrid zone, gradually dying away to an almost imperceptible phase in the polar regions.*

This phenomenon assumes the form of a diurnal pulsation, with a maximum about 9 A. M., and a minimum about 3 P. M., with a tendency to a corresponding maximum and minimum at 9 P. M., and 3 A. M. These latter pulsations are much less pronounced, and in the higher latitudes are scarcely appreciable. The diagram, Fig. I, illustrates this very marked feature.

It will be observed: (1) That under these conditions the lune of daily minimum barometer is always in the easterly quadrant of the illuminated hemisphere, that the lunes farther east have just been exhausted, and that those to the west are at their maximum. (2) That this action takes place continuously at each revolution of the earth. (3) That cloudiness accelerates and intensifies the action by appropriating all of the solar energy reaching the clouded areas. (4) That it is not counteracted in any way whatever.

Therefore, there results a constant lune of lowest barometer always in the easterly quadrant of the illuminated hemisphere,

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*See *Physical Geography of the Sea.* MAURY. p. 210. 8th edition.
Elementary Meteorology. R. H. SCOTT, F. R. S. pp. 88–91.
DESCHANEL'S *Natural Philosophy.* 6th Edition. p. 165.

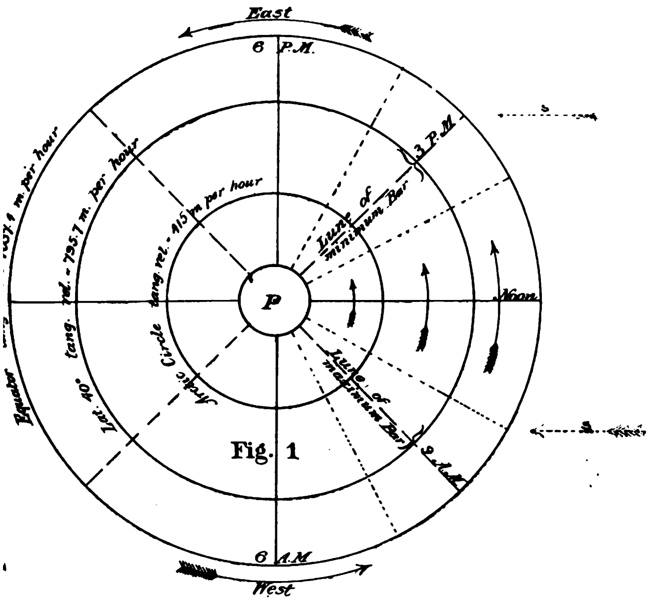

East
6 P.M.
3 P.M.
Lune of minimum Bar
Noon
Lune of maximum Bar
6 A.M.
West
Equator
Lat. 40° tang. vel. - 795.7 m. per hour
Arctic Circle tang. vel. - 415 m per hour
P

Fig. 1

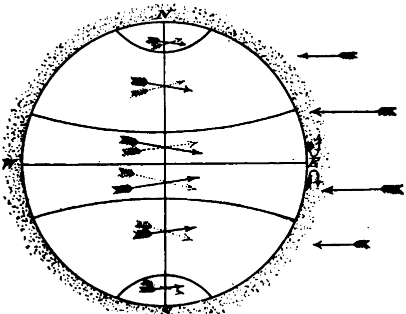
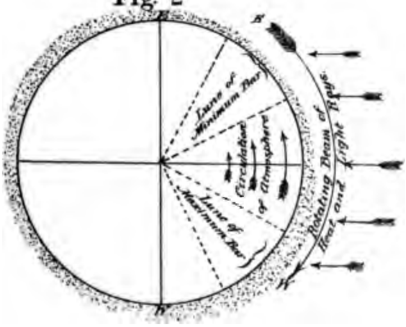
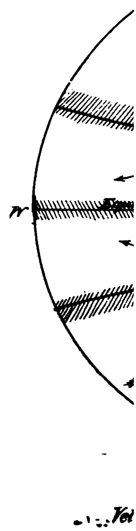
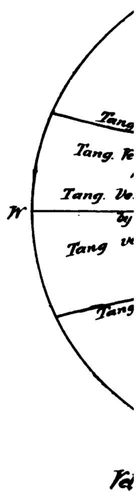

N
S

Fig. 2


Lune of Minimum Bar
Circulation of Atmosphere
Lune of Maximum Bar
Rotating Beam of Heat and Light Rays


W


W
Tang.
Tang
Tang

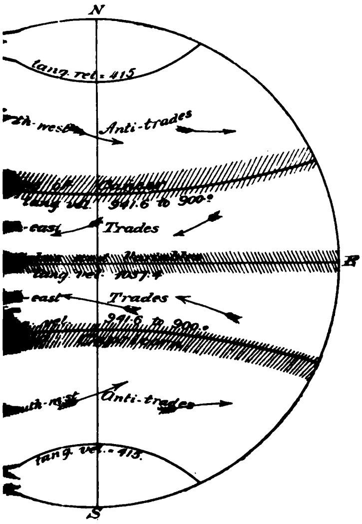
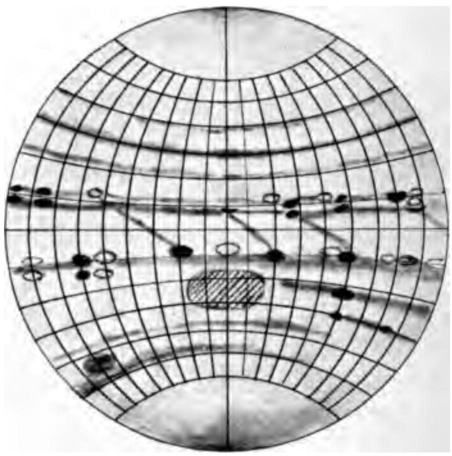


Fig. 3

...pressed in miles per hour.

Fig. 5



THE PLANET JUPITER, 1887.

Modified from the Mercator's Projection in Zenographical Fragments.

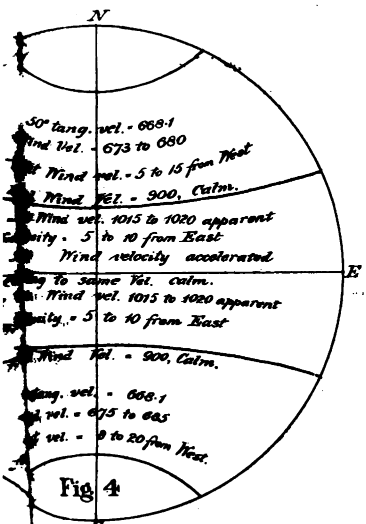


Fig 4

...pressed in miles per hour.

which, by reason of the daily axial revolution, moves round the earth from east to west about ninety degrees (or six hours) east of the lune of maximum barometer; this condition can only be satisfied by a constant flow of air in the direction of this barometric gradient, or from west to east.

As solar energy has its greatest effect in the torrid zone, and gradually decreases toward the poles, westerly currents and vertical circulation reach their maximum in that zone, and the lower strata of air in each hemisphere have a slight trend toward the equator, and the upper strata a necessary counter current toward the polar regions.

It becomes necessary here to explain the apparent stoppage of the winds in the calms of *Cancer* and *Capricorn;* the apparent reversal of the west winds into the easterly trades of the torrid zones; and the existence of a calm belt between these two belts of easterly trades.

For illustrative purposes, let us assume a sphere in space, without axial rotation, and surrounded by an atmosphere similar in composition to that of the Earth. Around this sphere let us further assume a beam of heat and light to revolve from east to west, successively heating the air.

Barometric phenomena, similar to those now known to take place and illustrated in Fig. I, will be inaugurated; and if the revolutions of the beam of heat could be accomplished in twenty-four hours, and the heat received by each hemisphere be in whole or in part lost during the following period of non-exposure, the atmosphere surrounding our illustrative sphere would flow around it from west to east; and as the zone of nearly normal rays would be most acted upon, the west winds of that zone would be the strongest and the vertical circulation greatest. There would also be established a series of counter currents in the upper atmosphere trending toward the poles, and the resulting circulation would be as represented in Fig. II.

It will be observed: (1) That the strongest westerly winds and vertical circulation upon our non-rotating sphere will obtain under the zone of vertical rays, and that these winds will gradually decrease in force toward the polar regions, to die away at the poles. (2) That surface winds will trend toward the equatorial regions by reason of the greater vertical circulation there established, and an upper system of counter currents will trend toward the polar regions. These two wind systems will there-

fore be as represented by the full and dotted arrows in Fig. II, the varying lengths being intended to indicate the proportionate strength of the currents.

Now, instead of the assumed and impossible stationary sphere and revolving beam of heat, let us substitute the simple and actual stationary beam of heat and the rotation from west to east of the sphere. There will be no change in the forces tending to cause the atmosphere to circulate about the sphere, nor will conditions be introduced which would in any way tend to counteract such circulation, but remarkable relations between the atmospheric circulation and the moving surface will be introduced. All latitudes of the surface will travel with the atmosphere, but with varying relative velocities in each latitude.

In regions where the two velocities are equal, there would be apparent calms. In regions in which the tangential velocity exceeded the atmospheric velocity, there would be a differential motion — the planetary surface, moving to the east at a greater speed than the air, would pass the air, giving rise to an apparent east wind. The air would be going to the east with the lesser velocity. In regions in which the tangential velocity of the surface was less than the atmospheric velocity, there would be an actual west wind, the air in this case moving to the east with the greater speed.

The greater vertical circulation at the equator with its necessary oblique movement of air toward the equator at the surface and toward the poles in the upper atmosphere, need not now be taken into consideration, for as will be shown later, the ratio between longitudinal motion and latitudinal motion in the great body of the air is as 720 to 36, or 20 to 1; in the thin stratum next the surface these ratios do not obtain.

The question of whether the atmosphere would revolve with the planet, irrespective of the effect of solar energy, is not considered. The principal subject under discussion is the accelerating effect of solar energy. In temperate latitudes, where the rays pass obliquely through the atmosphere, this accelerating effect is so great as to cause the atmosphere to revolve faster than the Earth.

The tangential velocities are expressed in the table appended, which gives the velocity of the surface at sea level for each ten degrees of latitude. It is practically correct, but subject to very slight corrections, as the exact form and dimensions of the Earth shall be more minutely ascertained.

TANGENTIAL VELOCITY OF EACH TEN DEGREES OF LATITUDE FROM THE EQUATOR TO THE POLES.

Latitude.	Tangential Velocity in Miles Per Hour.	Remarks.	
0°	1037.4	Equator.	Calm.
10°	1021.8		
20°	975.3		Easterly Trades.
23½°	941.6	Tropics.	Calm.
30°	899.1		
40°	795.7		Westerly Anti-trades.
50°	668.1		
60°	520.0		
66½°	415.0	Polar Circles.	
70°	355.8		
80°	180.7		
90°	00.0	Poles.	

The appended diagram of the wind systems of the globe, Fig. III, is familiar and generally accepted. The variations are many, and produced by various causes, the principal of which are the different proportions of solar energy taken by ocean and continental areas; the varying exposure of winter and summer, and the transfer of heat by ocean currents, each of which locally complicates the actual phenomena, but all are foreign to a discussion of the prime problem, and will not now be considered.

It will at once be admitted that in the region of the anti-trades, or north and south of the calms of *Cancer* and *Capricorn*, the circulation agrees with that established and explained in Fig. II. In other words, between thirty-five degrees and sixty degrees in both hemispheres, the air circulates about the globe from west to east a few miles faster per hour than the tangential velocity in those latitudes. But about latitude thirty degrees, the acceleration in tangential velocity brings it up to the westerly circulation of the atmosphere, and both reach a velocity of about 900 miles per hour, and hence a region of calms. Between these two calm belts there is a zone in which the motion from west to east is actually greater than in the calm zones on each side, but owing to the proportionately greater increase in tangential velocity, these

stronger west winds appear to be east winds — the earth slipping under the air faster than the air circulates.

In the center of this great belt of easterly trades is a narrow belt of calms and variables — in which the velocity of the atmosphere and the tangential velocity are equal.

This narrow belt of calms is under the equatorial cloud-ring, and is exposed to vertical rays, and, by reason of its cloudiness, intercepts a larger portion of solar energy than the less clouded areas to the north and south of this ring. The effect of this intercepted heat is to accelerate the westerly currents of that region, thus equalizing the two velocities, and resulting in the equatorial calms.

The general relations of the tangential velocities to the actual atmospheric velocities are outlined in Fig. IV. The apparent atmospheric velocities or winds are the differences between the actual surface velocities and the actual atmospheric velocities.

It would be difficult to verify these views from the ordinary meteorological observations, particularly in the torrid zone; but an opportunity to observe the movements of the atmosphere on a grand scale was inaugurated on August 27th,* 1883, when in latitude six degrees nine minutes south, the volcanic island of Krakatoa, in the Straits of Sunda, was suddenly disrupted with a degree of violence unknown to history.

The Royal Society of London appointed a committee in December, 1883, to collect and put on record the observations made throughout the world upon the consequent phenomena. The results of the labors of this able committee were published in December, 1888, by G. J. SYMONS, F. R. S., chairman of the committee. From this valuable work the following outline is condensed:

The most violent explosions were heard at a distance of 2500 miles, and over one-thirteenth of the area of the globe, and threw a column of volcanic dust and vapor to a vertical height of from seventeen to thirty-one miles. The wave of atmospheric concussion traversed the globe to the antipodes of Krakatoa in sixteen hours, and, successively rebounding back and forth, compassed the globe seven times before subsiding. Every barometer marked seven successive passages of this rebounding wave, but its passage was rarely recorded except upon the baro-

* At this date the Sun was vertical over latitude thirteen degrees fifty-five minutes north.

graphs of the observatories. Masses of lava were thrown to a distance of fifty miles, with an initial velocity of 2500 to 3500 feet per second. The total volume displaced was about one and one-eighth cubic miles.

This vast dust column was borne by the winds twice and a half times around the Earth before being dissipated, making each circuit in about twelve and a half days, apparently in a westerly direction, and at an average rate of seventy to seventy-seven and two-tenths miles per hour. The probable maximum speed being estimated at eighty and three-tenths miles per hour, and by the celebrated Dutch engineer, VERBEEK, at eighty-two and nine-tenths miles per hour.

In the first circuit, the diffusion was over a zone of about thirty-one degrees in width; in the second, about sixty degrees in width; the center of each zone being practically the latitude of the explosion.

After passing latitude thirty-five degrees north, the further extension up to sixty degrees north was from the southwest.

From page 431 of the *Report* cited, the following quotation is introduced:

"If we analyze these, we shall find that on their first circuit, the mean latitude of the center of the band of the twilight glows, was six degrees ten minutes south (the latitude of Krakatoa being six degrees nine minutes south), and their mean extension north and south of this position was ± fifteen and one-half degrees.

For the colored suns, the mean latitude of the center of the band was five degrees twenty-six minutes south, and the mean extension of the phenomenon north and south of this was ± ten degrees and forty-nine minutes. The latter, therefore, was more restricted than, but very similar in position and extension to, the former.

During the second circuit, the limits are not so determinate; but, omitting extremes, we may take the twilight glow band to have had its central line about six degrees south, and to have extended north and south of this for about ± thirty degrees.

Up to October 5th, this rate of expansion for the stream seems to have been fairly maintained, but after this epoch we find a distinct retardation in the latitudinal spread of the main body of the haze, and thenceforward its course is doubtful. Apparently, it reached latitude thirty-five degrees by the end of October; then, in November, a sudden rush took place, which, by the end of the

same month, caused the phenomenon to be seen over the major part of North America and Europe, up to latitude sixty degrees. A change in the direction of motion appears to have taken place in October, after which the material seems to have been wafted along by a different set of currents.

Whether the material spread by the action of any other laws than those which usually regulate the motion of the air in which it floated, and at what time it ceased to move from east to west, it is difficult to say;*† but the facts negatively favor the view that by the time it reached latitude thirty degrees, it no longer possessed that due east to west direction, by which, at first, its general motion within the tropics was so markedly characterized. Beyond this limit, the facts relating to the march of the glows over North America, Europe, and Northern Asia, show that the current which brought the glow-causing material, whether simply the southwest anti-trade, or a current analogous to it at a higher level, carried it more from west to east than from east to west. There is, indeed, a remarkable absence of any succession of appearances from east to west beyond latitude thirty degrees north, *and a general impression conveyed by the facts that while the material was crossing this limit, it was simply spreading north and south, and afterward turned around so as to move, if anything, from southwest to northeast.*† If this was the case, its general motion beyond the tropics was similar to what that of the usually so-called higher parts of the atmosphere should be, according to the modern theory of atmospheric circulation."

It will be observed that in this quotation very important facts are recorded, but that a remarkable interpretation of them is rendered in referring to the apparent motion of the dust cloud, at from seventy to eighty-three miles per hour, from east to west, as an actual velocity in that direction — when in reality at this latitude this dust cloud was being borne in the opposite direction at much greater rate of speed.

The fact that this dust cloud traversed the Earth twice between latitude $\pm$ thirty degrees is beyond dispute. The observed time of passage was twelve and a half days, or three hundred hours. The distance accomplished in each circuit was the equatorial circumference of the Earth, at an altitude of twenty or

* Such as electrical repulsion.

† Italicized by the present writer.

thirty miles, or practically 25,000 miles. The tangential velocity of the equator is 1037.4 miles per hour from west to east.

By that well-known and useful principle established in the "Problem of the Couriers," the time necessary for one body to overtake another moving at a different rate, is found by dividing the distance between them by the difference of their rates of speed, or $T = \frac{D}{r - r_1}$ in which $T = 300$ hours; $D = 25{,}000$ miles; $r = 1037.4$ miles per hour, to find the velocity and direction of the dust cloud r_1.

Substituting these values, we find $r_1 = 954$ miles per hour. The sign being positive, the direction of motion is the same as the tangential velocity, and the difference between the two velocities is eighty-three and four-tenths miles per hour. In other words, the dust cloud, instead of being borne around the globe from east to west at an average speed of eighty-three and four-tenths miles per hour, was actually traveling in the opposite direction at a speed nearly eleven and one-half times greater, but the lost motion, or lagging behind the tangential velocity, was eighty-three and four-tenths miles per hour, giving an apparent motion from east to west. When the dust cloud reached the latitude of the tropics, or the calm belts, it traveled at the same velocity as the surface beneath, hence the "retardation" in October, 1883.

Upon passing north of the calms of *Cancer*, the haze reached the southwest upper currents, overspreading the northwest anti-trades, and moving faster than the surface beneath, and hence the apparent change in the direction of motion, and its spread over Northern Asia, Europe, and North America from the southwest. The change in direction spoken of in the quotation given was only an apparent change, due to the reversed relation between the tangential velocity of the surface and the velocity of the circulating air. The distinguished committee, in failing to correctly interpret the facts, found it necessary to partly attribute the motion of the dust cloud to "other laws than those which usually regulate the motion of the air in which it floated."

But when the principles herein developed are applied to the phenomena attending the movement and spreading of this volcanic dust cloud, these movements become grandly simple, and part of one harmonious whole.

We can also more readily interpret the two calm belts about

the tropics; starting in the torrid zone, or region of apparent east winds, where the tangential velocity is greater than the atmospheric velocity, and passing to the temperate zones, where the atmospheric velocity is the greater, we must pass through regions where the two rates of motion become equal, or the calm belts. Beyond these are the anti-trades, or the region of actual westerly winds, in which the velocity of the atmosphere is the greater.

In the regions of northwest and southwest trades, there is a proportionately greater acceleration, due to the greater appropriation by the atmosphere of the heat rays reaching those latitudes. By reason of the obliquity of solar rays, in latitude ± fifty degrees, nearly twice as thick a stratum of air must be passed through as at the equator; hence a larger proportionate amount of heat is taken up, and proportionately a greater acceleration is acquired by the atmosphere of those latitudes.

Thus the apparently confusing motions of the dust cloud in latitude thirty-five degrees north, and its apparent reversal of motion in approaching Europe and North America from the southwest, become part of a general circulation, always in the same direction, and in accordance with the same fundamental laws, acting in the same manner and in the same direction in all latitudes.

This velocity of 954 miles per hour is that obtaining in the higher regions of the atmosphere about the torrid zone. The relative surface velocities are more nearly as represented in Fig. IV. If the actual velocities of the atmosphere at various latitudes be compared with the scheme deduced from Fig. II, the correctness of this latter is at once established.

In the temperate zones, the actual surface velocities are about 675 to 680 miles per hour, gradually increasing to ± thirty degrees where velocities of about 900 miles per hour exist. In the tropical trade-wind belts the actual velocities are from 1010 to 1015 miles per hour; and under the equatorial cloud ring the actual velocity is about 1037 miles per hour. The differences between these velocities, and the tangential velocities of the corresponding latitudes give the apparent directions and forces of the winds.

The northerly and southerly components are omitted in this discussion, which is limited to the fundamental principles. The Krakatoa dust cloud encircled the globe twice before passing beyond the tropical calm belts, or, in going through 720 degrees

of longitude, it went from six degrees south to thirty degrees north latitude, or in the ratio of twenty to one. At the surface these components are relatively more nearly equal in value, and hence the directions of surface winds are more oblique to the meridians than the ratio above given would indicate.

PHENOMENA PRESENTED UPON *JUPITER*.

When the physical conditions and phenomena existent upon *Jupiter* are fully grasped, they present, in their simplest and grandest form, the circulation of the atmosphere of a planet.

So far as our knowledge of *Jupiter* now extends, that planet is a mass of unknown size, shrouded in a densely clouded atmosphere. Not knowing the surface temperature of the inner planetary mass, nor the composition of the atmosphere, it is impossible to approximate the limit to which the gaseous envelope has been expanded. The cloud sphere evidently encloses a planetary mass, in which is still resident sufficient heat to control surface temperatures and to cause evaporation, thus maintaining the cloud sphere.

That evaporation is kept up on *Jupiter* by internal heat is made manifest by the following facts: Being 5.2 times more distant from the Sun than the Earth, he receives $\frac{1}{(5.2)^2} = .037$ of the heat per unit of area which the Earth receives. It is inconceivable that this amount of heat could keep up sufficient evaporation to shroud the planet in clouds. As will be shown later, this feeble amount of heat is entirely taken up in the atmosphere, and produces an atmospheric acceleration about the equatorial regions greater than the corresponding acceleration on the Earth. This decreased solar energy, by reason of producing a greater comparative acceleration, must therefore be taken up in the atmosphere to a greater extent than in the case of the Earth. The very existence, therefore, of the densely clouded atmosphere, is evidence of a surface temperature maintained by internal heat. It is also evident, as radiated solar energy is so largely taken up by the clouded atmosphere, and as we can detect no more heat in the rays emanating from *Jupiter* than is due to reflected solar rays, that the dark heat rays emanating from the planet itself cannot escape except in the performance of work. Therefore, the function of the solar energy reaching that planet is simply to conserve the internal heat. The cloud sphere of *Jupiter* having

a diameter eleven and two-tenths times larger than that of the Earth, and being five and two-tenths times more distant, intercepts $(11.2)^2 \times \frac{1}{(5.2)^2} = 4.64$ times more heat; every thermal unit of which has only this conservative function to perform.

The surface of this cloud sphere is marked by a series of bands and spots ranged in zones parallel with the equator. These spots are either dark or light, and exist for many months. Their periods of revolution are observed with great accuracy. After these bands and spots, the most notable feature is the Red Spot, situated in the southern hemisphere, and extending from about fifteen degrees south to thirty-two degrees south, and over thirty-five degrees of longitude, or one-eleventh of the circumference of the planet. See Fig. V.*

The Red Spot has a mean period of revolution of 9^h 55^m 38.4^s, with a retardation of a few seconds per year for about six years, and then a similar acceleration. The most rapid revolution is 9^h 55^m 24.2^s, and the slowest 9^h 55^m 41.1^s. The spots in the bands have periods of revolution of from 9^h 55^m 46^s to 9^h 50^m 9.5^s.

Those immediately adjacent to and north of the Red Spot have periods of revolution some five minutes less than that of the Red Spot, so that in about forty-five days they make one more revolution than it does, or they make 110 revolutions whilst the Red Spot makes 109. This swifter motion causes them to pass by the Red Spot, when it exercises a "repellant influence" upon them. Mr. WILLIAMS refers to the results of his observations as "demonstrating the great probability of the existence of a real repulsive influence exercised upon neighboring objects by this remarkable formation." But he offers no explanation of this phenomenon. The spots more remote from the Red Spot have nearly the same period of revolution. All of these periods of revolution are therefore variable. These variations are set forth in the accompanying tables from a recent and very able work, *Zenographical Fragments*, by A. STANLEY WILLIAMS, F.R.A.S.

The column of latitudes has been added by the writer from other parts of the same work. These latitudes mark approximately the center of each spot. There has also been added the

* In this figure, the zero of longitude is made the center of the Red Spot, the only prominent permanent feature. The spots are distorted to appear as they would when the planes of their meridians pass through the Earth.

column marked "Size," in which the letters "L" and "S" mark the large and small spots, the others being medium in size.

SUMMARY OF ROTATION PERIODS.

MEAN MOTION OF MATTER IN DIFFERENT ZENOGRAPHICAL LATITUDES IN 1887.

NORTH TEMPERATE SPOTS.	H.	M.	S.	Latitude.	Size.
White Spot A	9	55	34.7	12½° N	
Dark Spot B	9	55	40.4	10	L
White Spot C	9	55	32.6	12½	L
Dark Spot D	9	55	37.7	10	L
White Spot D^2	9	55	34.1	12½	L
Dark Spot E	9	55	27.3	10	S
White Spot F	9	55	30.0	12½	L
Dark Spot G	9	55	26.0	10	L
White Spot H	9	55	26.8	12½	.
Dark Spot H^2	9	55	40.7	10	S
White Spot K	9	55	38.6	11	L
Dark Spot K^2	9	55	39.4	10	S
White Spot L	9	55	38.5	13	.
Dark Spot M	9	55	43.1	11	L
White Spot N	9	55	46.0	12	S
Dark Spot O	9	55	44.0	10	
White Spot P	9	55	40.4	12½	
NORTH EQUATORIAL SPOTS.	**H.**	**M.**	**S.**	**Latitude.**	**Size.**
Dark Spot 1	9	50	16.6	8° N	
Dark Spot 2	9	50	33.3	8	
Dark Spot 3	9	51	18.7	5	L
Dark Spot 4	9	50	44.9	4	
Dark Spot 5	9	50	26.8	8	L
SOUTH EQUATORIAL SPOTS.	**H.**	**M.**	**S.**	**Latitude.**	**Size.**
Dark Spot I	9	50	22.3	10° S	
White Spot II	9	50	20.4	7½	
Dark Spot III	9	50	21.7	10	L
White Spot IV	9	50	17.4	7½	
Dark Spot V	9	50	9.5	8	L
White Spot VI	9	50	12.0	5	
Dark Spot VII	9	50	19.7	8	L
Dark Spot VIII		?		8	
White Spot IX	9	50	24.9	6	
Dark Spot X	9	50	19.2	6	
White Spot XI	9	50	15.5*	6	L
Dark Spot XII	9	50	19.0*	10	L

SOUTH EQUATORIAL SPOTS.	H.	M	S.	Latitude.	Size.
White Spot XV	9	50	21.9	7½	
Dark Spot XVI	9	50	24.0	10	
White Spot XVII	9	50	25.4	7½	L
Dark Spot XVIII	9	50	19.7	7½	L
White Spot XIX	9	50	18.0*	7½	L
Dark Spot XX	9	50	24.3	11	S
White Spot XXI	9	50	25.2	7½	
Dark Spot XXII	9	50	27.2	8	
White Spot XXIII	9	50	26.6	7½	S
Dark Spot XXIV	9	50	18.7	10	
White Spot XXV	9	50	29.7	7½	
Dark Spot XXVI	9	50	36.5	10	
White Spot XXVII	9	50	24.1	7½	S

*** Spots marked thus have been rejected in ascertaining the mean motion of matter in about latitude 8° S., their periods of rotation not being known with sufficient accuracy.**

SOUTHERN SPOTS.	H.	M.	S.	Latitude.	Size.
Red Spot	9	55	40.5	24° S	L
White Spot α	9	55	21.6	30	
Dark Spot β	9	55	11.8	30	
Dark Spot γ	9	55	17.8	30	

	H.	M.	S.
Mean period of rotation of matter (from 17 north temperate spots) in Lat. 12° N.	9	55	36.49
Mean period of rotation of matter (from 5 north equatorial spots) in Lat. 4° N.	9	50	40.06
Mean period of rotation of matter (from 21 south equatorial spots) in Lat. 8° S.	9	50	22.4
Mean period of rotation of matter (from 3 southern spots) in Lat. 30° S.	9	55	17.1

(See page 111 of work cited.)

It will be observed that cloud spots in the equatorial regions have periods of revolution averaging some five minutes less than cloud spots in the less exposed temperate regions on either side; demonstrating that solar energy is the accelerating cause, and that the circulation of these spots is in accordance with the interpretation just rendered for the circulation of the atmosphere of the Earth.

It is probable that these spots are gyratory columns of warm air rising from and descending to the surface; the two forming essential components of the system of vertical circulation, and corresponding to the areas of high and low pressure, which alternately traverse the northern hemisphere at intervals of every few days.

It has been observed that during periods of great brilliancy and distinctness, the spots of the equatorial regions of *Jupiter* are subjected to a wave of acceleration passing westwardly in its action. The interpretation of this is, that in the upper strata, heat and light rays are at times partially arrested by cirrus clouds; during such partial interruption retardation takes place, and during non-interruption increased brilliancy and acceleration occur. The westward motion of the wave is due to the retardation by the cirrus cloud strata.

From the table just given it will be noted:

(1) That cloud spots in the south equatorial regions had, in 1887-8, a period of revolution faster than in any other portion of the visible surface.

(2) That in the north equatorial regions, nearly equal periods of revolution were maintained.

(3) That in the temperate latitudes, longer periods of revolution prevailed than in equatorial latitudes.

(4) That the Red Spot had a period of revolution distinctly slower than the adjacent cloud spots.

AN EXPLANATION OF THESE MOTIONS.

The Red Spot being the most permanent feature, an explanation of its oscillations and influence will first be offered.

It is evidently caused by the local escape of internal heat from the mass beneath, the *repellant influence* being due to the spreading of the heated currents as they rise, and to the consequent greater altitude and overshadowing effect of this remarkable feature.

The retardation and acceleration in its rate of revolution are due to the veering of the spot by the increasing force of west winds consequent upon the exposure of the southern hemisphere during one-half of the Jovian year, or five and ninety-three hundredths of our years. During the other half of the Jovian year these winds retreat northerly, permitting the Red Spot to assume a position in the atmosphere more nearly vertical over the

source of heat beneath, thus apparently retarding its motion to the east.

This acceleration and retardation of west winds, and the annual shifting of the belt of their maximum activity, are notably marked on the Earth.* It is very perceptible in its March and April passage over the central part of the continent of North America. It is also well known in the correlated shifting of the belts of trades and calms in the tropical latitudes of each hemisphere.

In spite of the slight variation in the rate of motion of the Red Spot, it affords the best measure of the Jovian day; and, taken for a long period, embracing both the summer acceleration and winter retardation, it gives the following measures:

Noting the mean period of rotation as fixed by 4,917 revolutions from July 10, 1879, to August 2, 1887, we have $9^h\ 55^m\ 38.4^s$ as the length of the Jovian day. This is four and two-tenths seconds longer than the shortest period observed in 1879-80, and two and seven-tenths seconds shorter than the longest period of revolution in 1885-86, about six years later.†

There also occurs in latitude forty degrees south, longitude fifty-five degrees to eighty degrees west, an indistinct spot of great size. So far as the author is aware, the exact time of revolution of this spot has not been observed. The opinion is ventured that it is caused by conditions similar to those producing the Red Spot, and that their periods are identical.

We have only to apply the principles herein developed to the varying periods of revolution of the belts of white and dark cloud spots in the atmosphere of *Jupiter*—and to bear in mind the non-diathermic character of his atmosphere—and these varying periods of revolution become simple, and in perfect accord with the explanations herein given for the wind systems of the globe. The wind system of *Jupiter* is more simple than ours, the acceleration in velocity being directly proportioned to solar exposure, and no heat is lost by passing through to a planetary surface having variable heat-appropriating powers.

The mean tangential velocity of the twenty-one spots observed in the south equatorial regions is 28,097.8 miles per hour.

The mean tangential velocity of the northern edge of the Red Spot (latitude twelve degrees thirty minutes south) upon

* See pages 578 to 663 of the *Report of the Chief Signal Officer, 1890.*

† See page 97, *Zenographical Fragments.*

the data just given is 27,149 miles per hour, the swifter motion of the freely-moving spots carrying them one more complete revolution in forty-five days than is made by the slower moving Red Spot. Those next to the line of juncture have a mean tangential velocity of 27,416 miles per hour, or they move 267 miles per hour faster than the northern edge of the Red Spot. In this forty-five-day period the south equatorial spots make 110 revolutions, and the Red Spot 109.

We have seen that in the equatorial regions of the Earth the Krakatoa dust cloud had a tangential velocity of 954 miles per hour, and that the surface of the Earth has a tangential velocity of 1037.4 miles per hour, or the partly transcalent atmosphere of the Earth does not keep up with the great equatorial tangential velocity; by reason of some of the heat passing through the air to the planetary surface beneath, the atmospheric tangential velocity lags, or is retarded by eighty-three and four-tenths miles per hour.

We therefore see that the lesser proportion of solar energy which reaches *Jupiter* produces an acceleration in tangential velocity above his enormous equatorial velocity, showing that his atmosphere takes up a much greater proportion of solar energy than does the atmosphere of the Earth, in which case the atmospheric velocity is actually less by eighty-three and four-tenths miles per hour than the equatorial tangential velocity.

There is upon *Jupiter* a delicate difference between the rates of motion in these spots; the dark spots move slightly faster than the white spots of the same belt.

This variation has also its analogue in terrestrial phenomena, for the cloudy low areas, which extend well up into the regions of high velocities, move several miles faster per hour over sea and land than do the clear high areas, which lie more in the slow moving, lower regions of the atmosphere.*

In the equatorial regions of *Jupiter*, direct solar energy causes the atmosphere to revolve faster than the planet itself, and hence the spots of this belt pass the comparatively fixed, yet floating, Red Spot. This spot, however, obeys the accelerated force of the summer winds of the southern hemisphere, which increase in force for one-half of the Jovian year, or five and ninety-three hundredths years; during the other half these winds decrease in

* See Weather Bureau U. S. Department Agriculture, monthly Charts I and IV, and corresponding tables.

force, and the acceleration is in part lost. The center of this belt of strongest winds shifts over a zone seven degrees eleven minutes wide, the inclination of the plane of the equator to the plane of the ecliptic being one-half of this arc.

In temperate latitudes the oblique rays are not capable of producing so great an acceleration, and hence the spots of these latitudes have longer periods of revolution. The northerly and southerly components of the Earth's wind systems are also greater than on *Jupiter*. This condition is brought about by the decreased heat received by the latter planet, and his shorter period of axial revolution.

The motions of the atmosphere of *Jupiter* are, therefore, simpler than those upon the Earth. This is due to the fact that upon *Jupiter* solar energy acts upon a more homogeneous surface than is offered by the partly clouded and partly clear atmosphere of the Earth, and by its varying heat-appropriating surfaces of land and water.

TELEGRAPHIC ANNOUNCEMENTS OF ASTRONOMICAL DISCOVERIES, ETC., IN AMERICA.

By Edward S. Holden.

In 1871, Dr. C. H. F. Peters, Director of the Hamilton College Observatory, addressed a letter to the Secretary of the Smithsonian Institution asking that the Institution should act as a central-office for communicating discoveries of planets, comets, etc., by telegraph. Steps were immediately taken by Professor Henry to arrange for such a service, and from 1873 to 1883 it was carried out under the auspices of the Institution. Great pains was taken by Professor Henry and Professor Baird to obtain the opinions of astronomers as to the best form of message, etc.*

These telegrams were decidedly useful to American science, in spite of many annoying errors which arose from the fact that the Institution had then no astronomer to serve as editor. The telegrams from discoverers received by the Institution were very often wrongly worded, and there was no control. These tele-

* See *Report of Smithsonian Institution*, 1882, page 57.

grams were widely disseminated by Associated Press dispatches; and in a more detailed and scientific form by the circulars of the Boston Scientific Society, edited by Mr. JOHN RITCHIE, from 1879 onwards. Mr. RITCHIE and Dr. S. C. CHANDLER, in 1881, devised a special cipher-code for transmitting such telegrams, which was submitted to, but not accepted by, the Smithsonian Institution. During 1882 and 1883 arrangements were concluded between the Harvard College Observatory and the Smithsonian Institution which resulted in the transfer of the control of this useful service to the Observatory on the formal acceptance of its Director.*

Mr. RITCHIE was appointed to take charge of this service, and Dr. CHANDLER (then also connected with the H. C. O.) calculated comet orbits, ephemerides, etc., for quick transmission to other observatories. The transfer of the Bureau of Astronomical Telegraphy from the Smithsonian Institution to the Harvard College Observatory was in direct agreement with the settled policy of the former establishment to relinquish its own work to other responsible institutions so soon as the latter are willing and competent to undertake it.

The beneficial effect of the change was immediately felt. It was principally due to competent and alert editorship, and only partially to the new code, which, however, received its full share of credit.

An equally efficient service is now maintained at Kiel by Professor KRUEGER, who uses, I believe, a different code.

The code devised by Messrs. RITCHIE and CHANDLER was similar to the "Science Observer Code" (described below). Its word-book was, however, WORCESTER'S Comprehensive Dictionary—an unfortunate choice. Many of the Commercial Code books (with a few pages of additions), as SLATER'S Telegraphic Dictionary, for example, would have served the purpose better. The most important part of Messrs. RITCHIE and CHANDLER'S system was not the cipher-code itself, but the introduction of control-words suitable for detecting and correcting errors of transmission or of translation. This very practical device will always be a part of every subsequent code. Almost any code will suffice, if sufficient checks are applied. No single code will be equally convenient to astronomers of all nations. The English language, with its illogical pronunciations and spellings, will always contain

* *Report of the Smithsonian Institution*, 1883, page 33.

many puzzles to Europeans. With the object of improving the cipher-code (the fundamental principles and methods remaining the same), the Boston Scientific Society printed, in 1888, *The Science Observer Code,* prepared by Dr. S. C. CHANDLER and Mr. RITCHIE. The preface to this work gives an interesting account of its development from 1879 to 1888.

The code consists of four parts. Part I is an explanation of the principle of the code with detailed accounts and examples of its use, and Part I^{A} is the Number Code. The latter is printed on 200 quarto pages, in double columns, and the column is the unit. Each column is numbered (from 1 to 400) and each contains 100 words—40,000 words in all. Opening the book, at random, at column five, the last words of this column are:

80	Acodalar	90	Acollarado
81	Acodiciar	91	Acollarar
82	Acodillar	92	Accolerge
83	Acogedizo	93	Acollido
84	Acogeta	94	Acollonar
85	Acogido	95	Acology
86	Acogollar	96	Acolytes
87	Acogombrar	97	Acolythist
88	Acogotar	98	Acomendar
89	Acolcetra	99	Acometedor

Opening once more at column 240, we find the first words of this column to be:

0	Grouping	10	Groyne
1	Groups	11	Grozzer
2	Grouse	12	Grubaxe
3	Groveled	13	Grudge
4	Groveling	14	Grudgeful
5	Growlers	15	Grudgeth
6	Growlingly	16	Grudgingly
7	Growls	17	Gruffly
8	Growth	18	Gruffness
9	Growthead	19	Grugery

A Spanish or Italian telegrapher would be at home in the first set of words, but he could not pronounce the second set at all. It is not easy for an American telegrapher to even spell the first set, as we know by many experiences over the Mount Hamilton telephone wire. The selection of words from all languages has resulted in pleasing no one; for the *Science Observer Code* is, I

believe, not used in Europe, and its large proportion of long Spanish words is not welcome in America. It is probable that these were selected on account of the consistent rules of Spanish pronunciation. But when they are in the mouths of American telegraphers, they are pronounced by strange and novel American rules, and the practical result is that they are slowly spelled out, letter by letter. As very many of them consist of nine or ten letters, this is a wearisome process and it tends to introduce errors. In the selection of the words, care was taken that each one should differ from every other by at least two letters. This is, however, a difference which is chiefly effective *to the eye.* It is more practical to select cipher words which sound differently to the ear. A large number of the cipher messages are received and sent by telephone. I think every user of this code is more or less dissatisfied with the selection of its words, although all recognize the great merits of the general principles on which it is based.

The words of the first 200 pages are used as follows: *Acogedizo* stands for 583, *Grozzer* for 24,011, etc. There are forty thousand such words used to express the numbers 1 — 40,000. They occupy 200 pages. A much simpler method to express such numbers is to form *two* tables (printed on two pages only), and to make each cipher-word out of a prefix and an affix. Table I would give over 500 *prefixes*, each of three letters; as *Baf, Bak, Bal,* . . . . *Baz; Daf, Dak, Dal,* . . . . *Daz; Waf, Wak, Wal,* . . . . *Waz*, etc. Each one of these is numbered 1 — 500. In choosing such prefixes, it would be necessary to reject those likely to produce confusion to the ear. Thus *Bag* and *Bak, Bas* and *Baz* should not both occur in the cipher-code; initials G and J should not both be employed; terminals *am* and *an* should not both be included; and so on. Other similar precautions, familiar to users of cipher-codes, must be observed, so far as the resources of the language permit.

Table II would give 99 *affixes*, each of five letters, as *—aside, —aglee, —omous, —ulate*, etc. These would be numbered 1 — 99. Any number of five figures, less than 50,000, can be made up of a cipher-word (always of eight letters) composed of any prefix *plus* any affix; as *Bafomous, Dakaside, Walulate*, etc. This is pure jargon, of course; but it is no worse than the quotations just given from the *Science Observer Code.* No English-speaking telegrapher will have any trouble with it. A cipher-code is necessarily a jargon. If its words are chosen

according to a system which is designed to avoid the particular errors which arise in the actual practice of telegraphy, such a jargon is preferable to one selected from ordinary dictionaries, especially from foreign dictionaries, which are arranged for quite another purpose and on very different principles. In any event the cipher-code should be as short as possible, on merely practlical grounds. A saving of 99 *per cent.* is worth making.

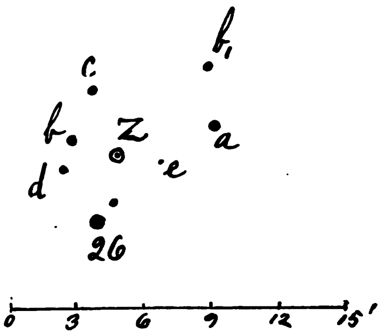
In order to show that a code of two pages is practicable and can take the place of the much longer code of the *Science Observer*, I propose to write such a one out in full at a future date—not, however, with any idea that it should now replace the system familiar to Americans, but simply to illustrate the principle to be followed in such codes.

Part II of the *Science Observer Code* is a "Phrase-Code." The arbitrary cipher-word stands in one column, and opposite it is the corresponding phrase — thus "Uglily" stands for "June 16"; "Unlawful" for "These are elliptic elements," etc. Part III comprises a few necessary tables. My own opinion is that Part II of the *Science Observer Code* contains too many rather than too few arbitrary symbols. It is always safer to transmit a message, which has to be handled by rather ignorant telegraphers, in plain English than in cipher. This was well illustrated in the famous cipher-dispatches of the Presidential campaign of 1876 (the keys to which I was among the first to detect)*.

The cipher used in most of these political dispatches was an excellent one, but the messages were mangled beyond recognition in many cases. The same lesson (to use plain English when it is possible) results from the experience of all army and navy officers concerned in such business. The cost of English telegrams is somewhat greater than that of the corresponding cipher-messages, but cost is a very secondary matter compared with freedom from error. The control-words of the *Science Observer Code* are extremely valuable in this regard.

The proposal to use a cipher-code for the transmission of important astronomical news, and the idea of introducing control-words to insure their accuracy, are due to Messrs. CHANDLER and RITCHIE. Their code has already rendered material benefit to astronomy. As the service is now conducted, astronomers are

* *See* my Report of 1879, February 21, to the Chairman of the Select Committee on Alleged Frauds in the Presidential Election of 1876, etc., and also, *The International Review* (N. Y.) for April, 1879, page 405.



The region about Z Cygni.

ɔf receiving early warnings of the appearance of a new ;, etc., and orbits and ephemerides can now be quickly uted and distributed. To any one who recollects the state ch matters previous to 1873, the improvement is most ɪg, and it is almost entirely due to the original suggestion of ETERS, to its prompt adoption by the Smithsonian Institu- and to the subsequent devices and able editorship of Messrs. IDLER and RITCHIE.*

ASTRONOMICAL OBSERVATIONS.

by TORVALD KÖHL, at Odder, Denmark, in the years 1894–95.

VARIABLE STARS.

Z Cygni.

1894.

ıry	1:	Z < e.	August	25:	< d.
	12:	< e.	September	1:	almost = e.
uary	1:	invisible.		6:	< e.
	13:	invisible.		23:	id.
h	25:	a little < e.		29:	id.
	6:	> e.	October	18:	invisible.
		< d.		26:	id.
	8:	almost = d.	November	10:	id.
	9:	id.		16:	id.
	24:	= b.		22:	id.
		a little < a.		30:	id.
	30:	= a.	December	12:	id.
	24:	> a.		14:	id.
		< 26.		16:	< e.
	3:	id.		30:	= e.
	29:	perhaps a little < d.			

---

uropean telegrams of the sort were formerly distributed by the Imperial Academy nces of Vienna, according to a code devised by Professor KARLINSKI, of Cracow, (*Ast. Nach*, Vol. LXV, col. 31; *ibid*, No. 1785.) The service was much neglected, be seen by the history of the new star discovered by SCHMIDT in 1876. It was ıtmost importance that this star should be observed at once. Accordingly, Dr. ɔT notified Vienna on November 24th by telegraph. The first account of the ːry was printed by the *Astronomische Nachrichten* on December 23d (a month The first news reached Berlin on December 3d, and so on. Half the astronomical of Europe was wasted for lack of a little administrative ability exerted ac- ; to an intelligent system.

1895.

January	1:	a little > e.
	21:	= b.
	26:	= a.
February	10:	id.
	14:	< a.
		> b.
	21:	= b.
April	12:	a little > d.
	16:	= d.
	25:	< d.
		> e.
August	16:	invisible.
	24:	< e.
September	9:	= e.
	13:	perhaps > e.
	20:	a little > e.
September	26:	> e.
		< d.
October	12:	> d.
		< c.
	30:	= b.
November	7:	perhaps < a.
	13:	id.
	18:	a little < a.
	19:	id.
	26:	id.
	29:	< a.
		> b.
December	7:	= b.
	8:	id.
	14:	id.

*X^2 Cygni.**

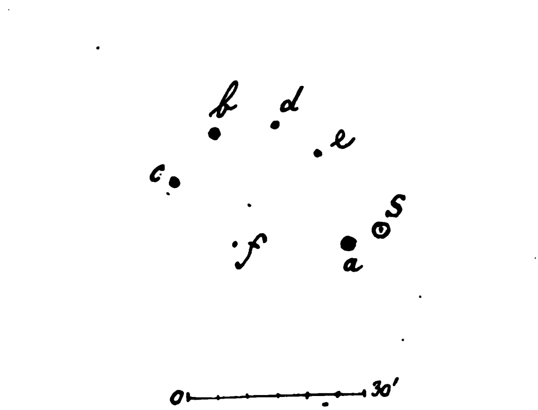
1894.

January	12:	X^2 = a.
March	25:	= k.
April	6:	< k.
July	29:	id.
August	23:	< i.
September	1:	very faint.
	23:	= i.
	29:	= h.
October	18:	= g.
	26:	id.
November	10:	X^2 = f.
	16:	= b.
	22:	> a.
		< A.
	29:	> A.
	30:	> A.
		< X^1.
December	14:	> X^1.
	16:	id.
	27:	id.
	30:	id.

1895.

January	1:	X^2 > X^1.
	21:	< X^1.
		> A.
	26:	id.
February	10:	id.
August	16:	< k.
	24:	invisible.
September	9:	id.
October	12:	id.
October	30:	X^2 < k.
November	13:	= i.
	18:	= h.
	19:	id.
	27:	id.
	29:	a little < g.
December	7:	= g.
	8:	id.
	14:	id.

* Vide *Publications* A. S. P., Nos. 33 and 34, page 37.



The region
about S Ursae maj:

The Stars A and B, near X^2 Cygni.

By examination of the region around X^2 *Cygni*, I have several years ago suspected a slight variation of the star *A* when compared with *B*,* as it is seen from the following estimations:

1878, March	4:	A < B.	1895, January	1:	A > B.
April	21:	A > B.		21:	A = B.
1879, March	15:	A < B.		26:	A = B.
1891, August	30:	A < B.	February	10:	A = B.
1894, November	22:	A > B.	November	29:	A < B.
	30:	A > B.	December	7:	A = B.
December	12:	A < B.		8:	A > B.
	14:	A = B.		14:	A = B.
	16:	A < B.			
	30:	A = B.			

X Cygni.

1895.

September	26:	X < a*. > b.	November	7:	X a little < a.
October	12:	a little > a.		13:	= a.
	17:	id.		18:	a little > a.
	20:	= a.		19:	id.
	30:	< a. > b.		25:	a little < a.
				29:	< a.
			December	7:	> a.
				14:	< a. only a little > b.

S Ursæ majoris.

1894.

January	26:	S = d.	September	23:	S a little < e.
February	1:	= e.		29:	< e.
	13:	a little < e.	October	1:	id.
	21:	id.		18:	= f.
March	2:	= f.		26:	< f.
	14:	< f.	November	10:	id.
	24:	id.		16:	id.
	29:	invisible.		22:	id.
August	23:	= d.		30:	invisible.
September	1:	id.	December	14:	id.
	3:	perhaps > d.		16:	very faint.
	8:	= d.		27:	< f.
	15:	id.			

---

* a indicates the next bright preceding, b the next following star.

1895.

January	26:	S = e.	September	6:	S invisible.
February	10:	id.		9:	id.
March	2:	perhaps > d.		13:	a little < e.
	17:	{ > d, < b (b = c).		14:	id.
				20:	= e.
	20:	= c (b > c).	October	12:	= d.
	27:	{ almost = c (b > c).		17:	id.
				30:	> d, < c.
	29:	id.	November	7:	= d.
April	2:	id.		13:	> d.
	9:	{ < c. > d.		18:	a little < c.
				19:	id.
	14:	= d.		25:	< c.
	22:	id.		29:	a little > d.
August	16:	= f.	December	7:	= d.
	24:	> f, < e.		8:	< d.
	31:	a little < e.		14:	a little < e.

*T Ursæ majoris.**

1894.

January	12:	T = b.	September	15:	T a little > a.
	26:	{ < c, nearly = d.		23:	{ quite a little > a.
February	1:	= d.		29:	= a.
	13:	= e.	October	1:	id.
	21:	< e, > f.		18:	= c.
March	2:	= f.		26:	a little < d.
	14:	< f.	November	10:	a little < e.
	24:	id.		16:	= f.
	29:	invisible.		22:	id.
April	9:	invisible.		30:	< g.
August	23:	> a.	December	14:	invisible.
September	1:	id.		16:	id.
	3:	id.		27:	id.
	8:	id.			

* Vide *Publications* A. S. P., No. 22, page 63.

1895.

January	26:	T invisible.	September	13:	T very faint.
February	10:	id.		14:	id.
March	2:	< g.		20:	id.
	17:	= f.	October	12:	< f.
	20:	id.		17:	id.
	27:	= d.		30:	id.
	29:	a little > d.	November	7:	id.
April	2:	> d, < c.		13:	= f.
	9:	< b, > c.		18:	a little < e.
	14:	= b.		19:	id.
	22:	a little > b.		25:	< d, > e.
August	16:	< f.		29:	= d.
	24:	invisible.	December	7:	= a.
	31:	id.		8:	id.
September	6:	id.		14:	a little > a.
	9:	id.			

Shooting Stars.

No.	Time, P. M.	Beginning.	End.	Magnitude.	Note.
	1894.	° °	° °		
1	Aug. 9 . $10^h\ 0^m\ 0^s$	255+16	252+13	2	
2	5 30	.	26+15	♀	Red Meteor, train.
3	8 30	261+39	255+35	3	
4	19 15	318+37	305+35	4	
5	22 0	260+47	246+27	3	Streak.
6	22 30	312+48	292+42	2	Train.
7	24 45	265+13	263+ 0	2	
8	39 0	27+60	17+57	2	
9	42 0	299− 7	297−12	2	
10	47 0	60+50	66+44	2	
11	49 30	350+34	344+24	2	
12	57 30	7+17	3+ 7	1	
13	58 30	8+25	356+14	3	
14	11 3 30	50+62	74+68	♀	Train.
15	19 0	282+ 7	273− 4	1	
16	23 30	354+44	332+38	2	
17	30 0	336+24	345+25	3	
18	33 15	295+42	285+29	1	Red Meteor, train.
19	34 45	305+15	295+ 3	1	
20	35 30	227+32	230+16	♀	Train.
21	36 0	267+ 8	267 − 1	♀	Train.
22	41 45	344+11	329+ 1	2	
23	52 30	328+41	355+34	2	
24	Aug. 10 . 10 26 30	352+27	345+18	3	
25	33 0	276+55	259+36	3	

SHOOTING STARS—*Continued.*

No.	Time, P. M.	Beginning.	End.	Magnitude.	NOTE.
	1894.	° °	° °		
26	Aug. 10. 10h 34m 30s	342+23	328+ 8	1	Train.
27	36 0	4+ 5	360+ 2	1	
28	37 40	320+44	303+35	2	Streak.
29	39 40	300+19	292+ 6	1	id.
30	40 50	325+17	314+ 5	1	Train.
31	50 10	318−11	306−18	♃	id.
32	56 0	6+18	360+ 8	1	
33	57 0	285+15	275+ 7	1	Streak.
34	11 3 40	356+ 9	352+ 5	1	
35	5 10	295+37	284+28	2	
36	6 30	3+16	358+ 7	2	
37	9 0	5+23	358+11	2	id.
38	11 10	330+56	309+45	♀	Train.
39	16 20	254+ 9	253− 2	1	
40	20 30	292+50	277+35	♃	
41	21 0	15+33	354+17	¼☾	Sparkling Meteor.
42	29 45	292− 1	286−11	1	
43	33 10	358+33	350+24	2	
44	41 25	316+23	306+11	3	
45	41 30	340−18	339−21	1	
46	47 30	4−10	1− 4	♀	
	A. M.				
47	Aug. 11. 12 4 40	288− 4	285−10	1	
48	5 40	5+15	359+ 5	2	
49	7 30	8+59	354+55	1	
50	8 50	236+71	231+52	1	
51	20 40	345−11	344−15	1	
52	29 30	298−11	297−17	♃	
	P. M.				
53	10 55 0	350+15	341+11	2	
54	11 11 21	314+42	301+37	3	
55	20 10	330+62	311+59	2	
56	23 30	14+54	360+54	2	
57	30 40	286+18	286+ 7	2	
58	32 40	. . .	7− 1	♃	
59	46 45	360+11	351+ 2	1	
60	51 30	322+15	312+26	4	
61	56 10	333−11	333−15	♃	
62	59 30	8+41	348+32	1	Train.
	A. M.				
63	Aug. 12. 12 6 0	356+30	346+19	2	id.
64	8 0	5+19	357+10	2	
65	11 45	338+ 0	18+11	♀	
66	20 0	310+40	297+30	2	
67	22 8	301+ 6	295− 5	1	
68	22 15	317+ 0	317−11	1	
69	27 20	340+18	326+ 4	1	Train.
70	30 10	297+14	290+ 4	3	

SHOOTING STARS—*Continued.*

Time, A. M.	Beginning.	End.	Magnitude.	Note.
1894.	° °	° °		
ug. 12. 12h 32m 0s	324 − 9	313 − 17	1	
1895.				
n. 25. 9 25 0	125 + 18	135 + 7	¼☾	Red Meteor.
ug. 10. 9 36 0	. .	303 − 9	½☾	Fireball. Train in several sections.
44 0	266 + 46	248 + 13	♃	
46 0	285 + 4	282 − 8	♃	Train.
10 16 15	266 + 23	255 + 8	3	Very fast.
22 0	319 + 5	300 − 6	1	
38 15	292 − 9	288 − 13	1	
11 2 0	341 + 10	337 + 5	1	
3 0	345 + 61	315 + 48	1	Very accurate.
12 30	261 + 18	254 + 7	1	
20 0	317 + 5	301 − 5	1	
39 0	357 + 34	340 + 20	♃	Train. Accurate.
44 50	25 + 22	17 + 6	♃	Train. Extinction near ☾.
55 0	306 + 50	284 + 36	2	Very accurate.
58 30	11 + 44	350 + 34	1	
58 33	335 − 5	326 − 16	♀	
A. M.				
ug. 11. 12 1 20	213 + 57	215 + 40	2	Accurate.
P. M.				
ug. 12. 9 52 0	287 + 40	276 + 34	3	
54 30	261 + 11	255 + 4	3	
10 1 0	297 + 39	247 + 23	2	
9 15	306 + 26	296 + 8	♃	Train.
10 45	327 + 17	223 + 1	1	
12 0	282 + 13	271 + 4	2	
15 30	297 + 41	259 + 37	2	Fast.
24 50	304 + 36	291 + 15	1	Train.
29 0	339 + 10	332 + 1	1	
33 0	. . .	15 + 66	♀	Very short path in direction from *Polaris.*
35 50	. . .	40 + 56	1	
42 40	319 + 2	333 + 5	3	Very slow.
48 30	333 + 10	326 − 1	2	
51 0	328 + 15	320 + 4	2	
11 9 10	293 + 10	296 − 5	2	
36 0	28 + 65	40 + 61	2	
42 45	26 + 24	20 + 14	♀	
47 0	273 + 15	263 + 5	♀	
pt. 26. 8 18 0	298 + 27	280 + 1	♀	

ɔ. 62 is also observed at Copenhagen (259° + 54° +—> + 33°, 2 Magnitude).

ɔ. 63 is also observed at Copenhagen (271° + 40° +—> + 25°, 3 Magnitude).

No. 65 is also observed at Copenhagen ($286° + 14° + \longrightarrow 259° + 36°$, ♀ Magnitude).

No. 69 is also observed at Copenhagen ($279° + 26° + \longrightarrow 271° + 11°$, 3 Magnitude).

No. 82 is also observed at Copenhagen ($268° + 14° + \longrightarrow 267° + 2°$, 2 Magnitude).

THESE FIVE METEORS HAVE GIVEN THE FOLLOWING RESULTS:

No.	Beginning.					End.					Real Length of the Path.
	h	λ		ϕ		h	λ		ϕ		β
		°	′	°	′		°	′	°	′	
62	110	1	4	55	55	81	1	44	55	44	54
63	109	1	11	55	37	87	1	35	55	30	37
65	115	1	20	54	30	54	0	55	55	39	148
69	118	1	44	55	15	88	2	15	55	3	50
82	52	2	8	55	24	45	2	30	55	16	28

Odder is situated in $2° 25'$ W. longitude from Copenhagen, and $55° 58'$ N. latitude.

h and β indicate kilometres; λ is W. longitude from Copenhagen; ϕ N. latitude.

Among other observations, the following may be noted:

1894. February 23d, a sun-spot was seen with *the naked eye*. May 4th, 9 P.M., the Comet *Gale* (6th magnitude) was discovered $1\frac{1}{4}°$ N. W. from 30 *Monocerotis*.

1895. August 9th, β *Ursae min.* was seen at 9^h P. M. by almost daylight with *the naked eye*.

November 28th, $5^h 30^m$ A. M., Comet *Perrine*, $14^h 14^m 28^s - 5° 8'$.

November 29th, $6^h 30^m$ A.M., Comet *Perrine*, $14^h 17^m 18^s - 5° 58'$.

November 30th, $6^h 30^m$ A.M., Comet *Perrine*, $14^h 21^m 18^s - 6° 53'$.

ODDER, DENMARK, January 3, 1896.

EPHEMERIS OF COMET *c*, 1895 (PERRINE).

By C. D. Perrine.

I have computed the following ephemeris from the elements given by Professor Campbell, in No. 45 of these *Publications*, page 344.

EPHEMERIS FOR GREENWICH MEAN MIDNIGHT.

1896.	App. α		App. δ		$\log r$	$\log \Delta$	Br.
	h	m	°	′			
March 1.5	19	47.0	+ 2	9	0.248	0.359	0.15
5.5		46.8	+ 3	15			
9.5		46.3	+ 4	21	0.280	0.361	
13.5		45.5	+ 5	27			
17.5		44.3	+ 6	34	0.309	0.362	0.11
21.5		42.7	+ 7	42			
25.5		40.7	+ 8	50	0.336	0.360	
29.5		38.3	+ 9	58			
April 2.5		35.4	+11	6	0.360	0.359	0.09
6.5		32.1	+12	15			
10.5		28.2	+13	23	0.382	0.355	
14.5		23.9	+14	30			
18.5		19.0	+15	37	0.403	0.352	0.07
22.5		13.6	+16	41			
26.5		7.6	+17	43	0.423	0.351	
30.5	19	1.1	+18	43			
May 4.5	18	54.3	+19	39	0.441	0.352	0.06

1896, February $5^{d}\ 18^{h}$. Correction to ephemeris:

In α —5^{s}.

In δ $+2'.9$.

As the observations upon which the orbit is based were made November 17th, 24th, and December 1st, before perihelion passage, the present corrections to the ephemeris will not vary rapidly.

Lick Observatory, February 20, 1896.

REPORTED EARTHQUAKES ON THE PACIFIC COAST.

FROM RECORD IN OFFICE OF FREDERICK G. PLUMMER, C. E.

NATIONAL GUARD OF WASHINGTON,
Chief Engineer's Office.
TACOMA, March 3, 1896.

Dr. E. S. HOLDEN, Director LICK Observatory, Cal.

Sir:—The following list of earthquakes for the Pacific Coast, from Alaska to Oregon, is submitted as a memorandum of such seismic events as have been tabulated by me from data collected during the past eleven years. The list is mainly valuable as a table to which corrections and additions can be made, and should not be taken as complete or correct. I shall be glad to receive any such corrections or additions.

Very truly,

FRED. G. PLUMMER.

Time.			Location.	Intensity.	Remarks.
Year.	Day.	h. m. s.			
1786	....	....	Pavloff ....A.	X	With volcanic eruption.
1788	....	....	Shumagin ....A.	.....	With tidal wave.
1788	July 27	....	Sannak Island ....A.	...	Overflowed by tidal wave.
1788	July 27	....	Ailiaska ....A.	...	Tidal wave.
1796	May	....	Bogoslov .... A.	...	With eruption.
1802	......	....	Unalashka ......A.	..	....
1812	......	....	Atka ....A.	X	....
1817	April	....	Umnak ....A.	X	....
1818	......	....	Makushin ....A.	....	....
1826	June	......	Unalashka. ......A.	....	Two.
1827	June	....	Copper Island. ...A.	....	....
1833	June 29	13 40 00	Fort Nisqually....W.	II	....
1836	April 2	....	Pribyloff Islands...A.	X	....
1836	August	....	Pribyloff Islands...A.	X	....
1847	......	....	St. Paul's Island...A.	VI	....
1854	......	....	Kaviak .... A.	IV	....
1856	Dec. 26	....	Port Townsend...W.	....	....
1857	Sept.	......	Birch Bay. ......W.	...	....
1860	May 7	...	Port Townsend...W.		....
1864	Oct. 29	Night	Victoria ....B. C.	VI	....
1865	June 12	....	Victoria ......B. C.	.	Several.
1865	Aug. 25	....	Victoria .... B. C.	IV	....
1866	Dec.	....	Dalles ....O.	III	....
1867	August	..	Lower Yukon ....A.	..	....
1867	Jan. 8	Morning	Klamath ....O.	VIII	....
1868	May 30	.....	Mukelteo. ....W.	...	....
1870?	Late	Night	Puget Sound..... W.	VII	Several old settlers insist that there were severe shocks, but none can state the day or time. Possibly they mistake the year for 1872.
1871	May 19	....	Tacoma. ....W.	...	....
1872	Dec. 14	21 40 30	Puget Sound......W.	...	One shock.
1872	Dec. 14	21 46 00	Puget Sound......W.	VII	Three shocks.
1872	Dec. 14	22 00 00	Puget Sound..... W.	....	Several shocks.
1872	Dec. 14	23 00 00	Puget Sound......W.	....	Several shocks.
1872	Dec. 15	3 00 00	Puget Sound......W.	...	Several shocks.
1872	Dec. 15	5 00 00	Puget Sound......W.	...	One shock.

Time.			Location.	Intensity.	Remarks.
Year.	Year.	h. m. s.			
1872	Dec. 16	9 17 30	Puget Sound......W.	....	One shock.
1872	Dec. 16	....	Eugene........... O.	....	One shock.
1873	Jan. 9	....	Tacoma......... .W.	II	....
1873	Nov. 22	21 00 00	Tacoma.... ..... W.	III	....
1873	Dec.	....	Olympia..... ....W.	IV	Three shocks.
1874	?	. .. ...	Tacoma.... .....W.	II	....
1877	Oct. 12	9 00 00	Cascades...... O.	....	....
1877	Oct. 12	13 53 00	Cascades...... ..O.	....	....
1879	?		Portland....... .. O.		....
1880	Dec. 6	17 54 00	Puget Sound......W.	IV	....
1880	Dec. 10	5 00 00	Puget Sound.. .. W.	IV	....
1880	Dec. 12	20 40 00	Victoria to Portland	VII	....
1880	Dec. 20	23 16 00	Puget Sound......W.	IV	....
1882	April 30	22 48 00	Portland. ... . O.	. .	....
1883	June ?	....	Tacoma ....W.	III	. ...
1883	Sept. 28	00 00 10	Portland.......... O.	...	Two shocks.
1884	Jan. 3	20 40 00	Portland...... .. O.	...	One shock.
1884	Sept. 21	22 30 00	Tacoma ....W.	....	....
1885	May 3	23 30 00	Olympia.... ... .W.	II	At intervals for two hours.
1885	Oct. 9	8 00 00	Olympia... ..... W.	III	....
1885	Oct. 10	1 30 00	Portland.......... O.	II	Three shocks.
1885	Dec. 8	22 12 00	Victoria.... .. B. C	....	....
1885	Dec. 8	22 40 00	Tacoma . ...W.	....	.. ..
1885	Dec. 18	0 30 00	Tatoosh Island...W.	....	....
1889	Fall	18 00 00	Puyallup.. ....W.	II	Several.
1891	Mar. 8	....	Olympia......... W.	III	... .
1891	Mar. 15	20 00 00	Roslyn......... ...W.	III	....
1891	Mar. 29	14 30 00	Roslyn........ ...W	III	....
1891	Sept.	....	Tacoma ..... W.	II	Several.
1891	Nov. 29	15 15 00	Tacoma .. . .W.	II	Two shocks.
1892	March	21 30 00	Kalama....... .. W.	..	....
1892	Apr. 17	14 55 00	Tacoma ....W.	II	Two.
1892	Apr. 17	14 55 00	Castle Rock......W.	II	Two.
1893	Feb. 16	....	Sidney............W.	II	....
1893	Aug. 14	5 07 00	Toutle River ...W.	IV	Vertical. Rumblings.
1893	Aug. 14	5 07 00	GreenRiverMines.W.	IV	Lateral. Rumblings.
1894	Apr. 15	20 56 00	Ellensburg.. . ...W.	III	Ten seconds.
1894	May 23	22 30 00	Tacoma ....W.	II	....
1895	Feb. 25	4 47 00	Portland. ....O.	III	Three shocks.
1895	Feb. 25	4 47 00	Tacoma ....W.	III	Three shocks.
1895	Feb. 25	4 47 00	GreenRiverMines.W.	V	Three shocks.

A.=Alaska. B. C.=British Columbia. W.=Washington. O.=Oregon.

OBSERVATIONS OF *MIRA CETI* (1895–96).

By Miss Rose O'Halloran.

[Abstract.]

Having made a diagram of the telescopic stars surrounding *o Ceti* in the beginning of 1895, I was able to identify it early in last October, when at its dimmest phase, or of the same magnitude as the gray-tinted orb which is 116 seconds distant from it. Though observed on every clear night since, I select from the record only those dates when a decided increase or decrease of brightness was detected, as the omitted observations are chiefly repetitions.

The names of the stars with which it has been successively compared will be given, as authorities differ somewhat in their estimates of magnitudes.

October 27th, November 8th and 16th, it seemed, respectively, three-tenths, seven-tenths, and one magnitude brighter than its companion star. Towards the end of the month it seemed rather to decline than to increase, but resumed its advance in December, and on the 10th was but one magnitude fainter than *66 Ceti*, and on the 20th, though still nearer to the brightness of that seventh-magnitude star, was invisible in an opera-glass of medium power.

December 21st. It was visible in the same opera-glass, though fainter than *66*, *70*, *71*, and *67 Ceti*.

December 26th. It was brighter than *71 Ceti*.

December 28th. It was as bright as *66 Ceti*.

December 31st. It was brighter than the last-named star, but was not discernible to the naked eye on that night.

January 1, 1896. It was nearly one magnitude brighter than *66*, and became dimly visible, without magnifying power, for the first time since its increase.

January 3d. It was brighter than *70* or *75 Ceti*.

January 5th. It was equal in magnitude to ν *Ceti*.

January 6th. It was brighter than ν *Ceti*, but was more than half a magnitude fainter than δ *Ceti*.

After an interval of cloudy weather, it was observed on January 18th, and seemed brighter than δ *Ceti*.

January 21st. It was much brighter than δ, but not so bright as γ *Ceti*, which is generally classed as of third magnitude. At this date *Mira* had probably attained its maximum brightness for this season, as careful comparison with the two last-named members of the same constellation revealed no decided change until February 3d, when a slight decrease was noticed.

February 5th. It seemed to have recovered its previous brightness, but on February 6th declined slightly, and then remained unchanged until February 12th.

February 13th was cloudy.

February 14th. It was very little brighter than δ *Ceti*.

There was no decided change until February 27th, when it was seen to be of the same brightness as δ *Ceti*, which, however, being a *Sirian* star, may have been more affected by the moonlight and twilight than the deep-tinted variable.

March 11th, *Mira* had decreased somewhat, and on March 14th, though of fifth-magnitude, it was scarcely discernible without magnifying power; and further observations of the interesting process of decline will have little value, owing to the increase of atmospheric disadvantages.

San Francisco, March 19, 1896.

PERSONAL EQUATION.

By R. H. Tucker.

[Abstract].

The effect of errors due to personal equation upon the determination of star places is, in general, included in two classes:

In one, the effect is eliminated. In the other, the error can actually be determined by observations similar to those affected, and the proper correction can be applied.

If the personal equation in transits remains constant, for the same conditions, the effect upon the observation of the stars from which the clock correction is obtained is the same as that for the stars whose Right Ascension is to be determined. While there may be variation in the amount of error, and investigations of the personal equation for the same observer at different epochs have actually given, in some cases, discordant values, these variations must, in general, be included with the accidental errors of observation. The constant or systematic error is eliminated.

If the error has a variation depending upon the magnitude, this can be investigated by the use of screens for some of the observations of bright stars; the results for stars thus reduced in magnitude being compared with corresponding observations made with full brightness.

The effect of the direction of motion can be observed upon stars at the zenith, reversing the position of the observer, as is done in the observations for bisection error, described later.

The effect due to the rate of motion is harder to deal with, and cannot be obtained directly from the observations. The results, however, when compared with the Ephemeris Right Ascensions of fundamental stars, at various distances from the

Pole, will indicate the amount of this variation, accepting the system of Right Ascensions as standard.

For the Declinations, the personal equation in reading the graduated circle is evidently differential, whether the Declinations are made to depend upon observed zenith distances or upon observations of fundamental stars.

In the former case, the error in observing the coincidence of the Declination wire, over the nadir, could be found by taking nadirs facing north and south alternately. But, from the manner in which this coincidence is usually obtained, by placing the wire alternately on both sides of its image, there is not much likelihood of there being a serious amount of personal equation.

If, also, circumpolar stars are observed at both culminations, to give the value of the latitude to be used in determinations of star places for the same epoch, this error is eliminated.

The bisection error is a form of personal equation that it is important to consider. If there is a tendency to place the wire too high or too low, or in case a pair of threads is used to place the star above or below the center of the pair, every observed zenith distance would be affected.

If the determinations are strictly differential, and the declinations are made to depend upon those of stars near, the effect is eliminated.

It would be doubled for determinations of stars on one side of the zenith, depending upon fundamental stars on the other side, and consequently doubled for determinations of south stars, depending upon a latitude from circumpolars at both culminations. The effect would, however, be eliminated from Declinations observed at both culminations.

As one conclusion from these relations, it is obvious that to free a set of south stars from this form of personal equation, which may be classed as a systematic error of observation, it would be best to use stars south of the zenith as fundamental. The circumpolar stars would be freed from its effect, by taking the mean of determinations at both culminations.

There would remain a zone of stars between the zenith and the limit at which observations below Pole can be made. For these stars it would be necessary to know the bisection error, and to correct for it.

The error is indicated by observations of the same star, above and below Pole; but these are generally made with an interval of

six months, and, as there is a method of obtaining this correction by observation of zenith stars, it is advisable to use both means.

To give this method in its simplest form: If two stars, culminating at the zenith are observed, one with the face north and the other with the face south, the effect of bisection error is doubled for a determination of the latitude from each. If, on another night, the same pair of stars are observed, each in the contrary position for the observer, the combination of the results of the two nights gives double the bisection error, free from any error in either star's Declination; and all systematic errors of observation other than that sought for are eliminated.

This process should be often repeated, that accidental errors of observation may have as little effect as possible upon the final result.

Repetition at intervals is useful, in order to check any variation of habit. For the present series of observations with the meridian-circle there have been made three sets of determinations, to be followed by others before the completion of the work, in order that the entire series may be represented. The first set consisted of a pair of stars on each of sixteen nights, four pairs being used. These were included in the regular observing programmes. The later sets have been made on special nights, with five or six pairs each night.

The transits, observed at the same time, should exhibit a difference, amounting to double the error due to direction of motion. While these observations are reduced, for the greater part, the combination of results will not be made until the close of the work, lest the knowledge of what error may be indicated should have some slight prejudice upon current observing.

THE CROSSLEY DOME ON MARCH 24, 1896.
(From a Negative by Professor HUSSEY.)

NOTICES FROM THE LICK OBSERVATORY.

Prepared by Members of the Staff.

Letter from Mr. Sydney D. Townley.

A letter received from Mr. Sydney D. Townley, a member of the A. S. P., formerly Hearst Fellow in Astronomy at the Lick Observatory, may be of general interest to members of the Society.

"Jaegerstr. 27, IV, Berlin.

"*Dear Professor Holden:*

"It has occurred to me that I might possibly be of service to American astronomers while abroad by offering to look for old books for them. I have made a number of excellent purchases for myself. I am going to Leipzig, Munich, etc., in the spring, so that I shall have an opportunity to search for books there as well as in Berlin.

* * * * * * *

"I am hearing lectures by Professors Foerster, Lehmann-Filhés, and Scheiner, and have some work in spectrum analysis at the Potsdam Observatory. Please give my congratulations to Mr. Perrine on the discovery of his comet, and with kindest regards to all at Mount Hamilton, believe me, etc.,

"S. D. Townley."

Meteor of January 4, 1896 (Minturn, California).

On January 4, 1896, at 6:48 P.M. (I think that was the exact time), I had the good fortune to witness another beautiful meteor. I was two miles southeast of Merced at the time. The general direction of the flight was about the same as the one of '94; it was visible fully five seconds, and it turned night into day. I expected to see some account of it in the papers, but as none

appeared, I concluded it was purely a local affair, though at the time, from its brilliancy and height of starting, it seemed as if it must be visible to all the country.

FRANK H. WEBSTER.

MINTURN, CAL., February 2, 1896.

BRIGHT METEOR OBSERVED AT NAPA, FEBRUARY 2, 1896.

"NAPA, February 2, 1896.

"Dear Sir:—My wife and I observed a bright meteor this evening at 6:33 (about). Its course was from about R. A. $23^h\ 30^m$, Dec.—15° to R. A. $3^h\ 20^m$, Dec.—28°. It was moderately bright. It moved in a very slow and leisurely fashion, taking at least thirty seconds before it disappeared. No report was heard. The path was of the same size and brilliancy throughout.

"Respectfully,

To Dr. E. S. HOLDEN. "H. D. CURTIS."

THE TROUVELOT ASTRONOMICAL DRAWINGS, WITH DESCRIPTIVE MANUAL, BY E. L. TROUVELOT. CHARLES SCRIBNER'S SONS, Publishers, 153–157 Fifth Avenue, New York.

This series consists of fifteen large colored plates, about thirty-six by thirty inches, with a descriptive manual. A private letter from the publishers informs me that they have reduced the price of the very few sets on hand to ten dollars, delivered in New York. Some of our members may like to know this.

E. S. H.

EXPLOSION OF AN AEROLITE IN MADRID (FEBRUARY 10, 1896).

"An aerolite exploded above this city to-day. There was a loud report, followed by a general panic. All buildings were shaken, and many windows were shattered. According to the officials of the Madrid Observatory, the explosion occurred twenty miles above the Earth.

The sun was shining clearly at the time of the explosion, and the only thing visible in the sky was a white cloud, bordered with red, which was traveling rapidly across the heavens, leaving behind it a train of fine white dust. When the explosion occurred, the populace believed it was an earthquake, or a sign of divine wrath.

Many injuries resulted from the panic which broke out among the people, and from the frantic attempts to escape from the factories and schools Seventeen persons were injured in one tobacco factory by the collapse of a staircase when the inmates rushed upon it to escape from the building. At the palace, it was at first feared a bomb had been exploded. Much damage was done by the force of the concussion."—S. F. *Chronicle*.

ELEMENTS OF COMET *a*, 1896, BY PROFESSOR A. O. LEUSCHNER AND MR. F. H. SEARES.

A cipher telegram from the Students' Observatory of the University of California, Berkeley, received February 18th, gives the following ELEMENTS OF COMET *a*, 1896:

$$T = \text{G. m. t., Jan. } 31.79.$$

$$\left.\begin{array}{l} \omega = 358^\circ\ 20' \\ \Omega = 208^\circ\ 48' \\ i = 155^\circ\ 43' \end{array}\right\}\ 1896.0$$

$$q = 0.5874$$

These elements are based on Mt. Hamilton observations by Mr. C. D. PERRINE, on February 14th, 15th, and 16th.

The elements have some resemblance to those of Comet 1855, II. E. S. H.

LICK OBSERVATORY, February 19, 1896.

[CIRCULAR.]

Post Office and Telegraph Department (Observatory Branch),
General Post Office, Adelaide, 22d November, 1895.

Dear Sir:—I have the pleasure of informing you that the Western Australian Government, as will be seen by the enclosed, have decided to establish an Astronomical Observatory at Perth, and Mr. W. ERNEST COOKE, M. A., the Assistant Astronomer at Adelaide, has, on my recommendation, been appointed Government Astronomer to that colony.

As the infant institution has no library, may I ask your kind assistance in supplying the new observatory with copies of your publications.?

I have the honor to be, Sir,

Your Obedient Servant,

CHARLES TODD,
Government Astronomer,
Postmaster-General and Superintendent of Telegraphs.

COMET *c*, 1895 (PERRINE).

This comet was last observed at the LICK Observatory on December 12th, G. M. T., before it passed the Sun going eastward. It was again glimpsed for a few minutes in the evening of December 20th, but so close to the horizon that no observation was possible. Cloudy weather about this time prevented its being seen again until January 30th, when it had again become a morning object. The weather has been good and a number of observations have been secured since. It is following the orbit computed for it by Professor CAMPBELL very closely, as will be seen from the corrections to the ephemeris published elsewhere in this number.

It is considerably fainter than at discovery, but is still faintly visible in a three-and-a-half inch telescope. The stellar nucleus has been plainly visible although much diminished in brightness, and a short fan-shaped tail has been observed with the twelve-inch equatorial.

The *Observatory* for January prints the following telegram from Cape Town to the "Times" under date of December 25th:

"A comet has been visible during the last few evenings, which Dr. GILL says is the comet discovered by Mr. PERRINE on November 17th. It is moving northward and less rapidly eastward, and is diminishing in brilliance nightly."

C. D. PERRINE.

LICK OBSERVATORY, February 27, 1896.

COMET *a*, 1896 (PERRINE).

The discovery of this comet was the very unusual result of an error due to a mistranslation of a telegram received at the LICK Observatory on February 14th, from Boston, giving an observation of Comet *c*, 1895, at Kiel. Observations of Comet *c*, 1895, had been obtained here since January 30th, and it was found to be following its ephemeris quite closely. The morning of February 15th (next following the receipt of the observation from Kiel), while observing Comet *c*, 1895, I looked up the new position, which agreed with ours in Declination, but was about thirty minutes *preceding* in Right Ascension, and not far away found a new comet, moving rapidly north and east. An observation showed the following position:

February 15.0839 Gr. M. T.

α 19^{h} 21^{m} 57.9^{s}

$\delta -$ 2° $49'$ $1''$

From observations on February 15th, 16th, and 17th, by the writer, an orbit was computed by Professor LEUSCHNER and Mr. SEARES, of the University of California, and the following elements obtained:

$$T = 1896,\ \text{January } 31.79$$

$$\left.\begin{array}{l} \omega = 358^{\circ}\quad 20' \\ \Omega = 208\quad 48 \\ i = 155\quad 43 \end{array}\right\}\ \text{Mean Eq. } 1896.0$$

$$q = 0.5874$$

The comet's apparent motion increased rapidly as it approached the Earth. Its nearest approach occurred on the 25th inst., and its apparent motion is now decreasing.

The comet at discovery, on the 15th, was at least twice as bright as Comet *c*, 1895, its light being about equal to that of an eighth-magnitude star. It was quite large, with a decided condensation in the head, but no stellar nucleus could be seen. It had a short, faint tail, which had almost disappeared a few mornings later.

The comet is now far enough north to be visible in the evening after sunset.

There is some similarity between the elements of this comet and those of 1855 II. A series of photographs has been secured by Mr. A. L. COLTON.

C. D. PERRINE.

LICK OBSERVATORY, February 27, 1896.

BRIGHTNESS OF COMET *a*, 1896 (PERRINE).

At the time of discovery of this comet, on February 15th, I estimated its brightness as about equal to that of an eighth-magnitude star. Its theoretical brightness increased to about 1.32 on February 25th, since which time it has been (theoretically) decreasing rapidly. On March 10.5 Gr. M. T. its brightness is computed to be about 0.23 that at discovery. To-night I examined this comet for the first time in two weeks, and was surprised to find it brighter than at discovery. It is certainly as bright now as a seventh-magnitude star, and seems a little more condensed.

C. D. PERRINE.

LICK OBSERVATORY, March 10, 1896.

REMARKS ON THE PROGRESS OF CELESTIAL MECHANICS SINCE THE MIDDLE OF THE CENTURY, BY DR. GEORGE W. HILL.

The Presidential Address delivered by Dr. GEORGE W. HILL before the New York Mathematical Society, on December 27th, 1895, has been reprinted in *Science* for March 6, 1896. Its title is given here, in order to call the attention of those of our members who are interested in celestial mechanics to a *resumé* of its history since 1850 (especially to an analysis of the new methods of GYLDÉN and POINCARÉ) from the hand of a master.

E. S. H.

A SMALL CRATER IN *CYRILLUS* DISCOVERED ON LICK OBSERVATORY PHOTOGRAPHS BY PROFESSOR WEINEK.

Professor WEINEK continues to find new craters in his enlargements of the negatives taken at the LICK Observatory, of which the following may be taken as an example:

In his enlargement of the negative taken at the LICK Observatory on June 27, 1895, Professor WEINEK found (on January 10th of this year) a new crater, about 1.1 *km.* = 0.7 English miles in diameter.

M. GAUDIBERT (on January 20) writes: "This evening from five to seven o'clock I have seen, most beautifully, the craterlet on the top of the central mountain of *Cyrillus*. At five hours I could see only half of it, the rest being still in shadow. At seven hours the whole was quite plain and seen very easily with my 260 *mm.* telescope. It was seen also with the six-inch aperture."

The map of the Moon on a scale of ten feet to the diameter, made by Professor WEINEK by direct photographic enlargement from negatives taken at the LICK Observatory (and also from negatives taken at the Paris Observatory), is now well under way, some 450 enlargements being on hand. E. S. H.

ERRATUM IN PUBLICATIONS A. S. P., VOL. VIII, PAGE 27.

The instruments mentioned as being made, by Mr. SAEGMÜLLER, for the College of Notre Dame, are in fact in course of construction for the private observatory of Mr. LUCIUS HUBBARD, of South Bend, Indiana. E. S. H.

TELESCOPES MAKING FOR OBSERVING THE ECLIPSE OF AUGUST, 1896.

Mr. BRASHEAR has just completed a six-inch photographic lens (of forty feet focus) for the LICK Observatory, which will be used by Professor SCHAEBERLE at the August eclipse in Japan.

The University of Tokio will have an eight-inch photographic doublet, and Dr. CHARLES L. POOR, of the Johns Hopkins University, a four-inch doublet, both of which are intended for use on the same occasion.

E. S. H.

[TRANSLATION.]

ASTRONOMICAL SOCIETY OF BELGIUM,
BRUSSELS, February 19, 1896.

To Professor EDWARD S. HOLDEN, etc.

"I have the honor to enclose several copies of my note on the 'Observation of Shooting Stars,' and I beg you to distribute them to those astronomers of the LICK Observatory and to those members of the Astronomical Society of the Pacific who are interested in such work."* . . .

PAUL STROOBANT.

THE LICK OBSERVATORY COLLECTION OF PORTRAITS OF ASTRONOMERS.

I beg to return the sincere thanks of the LICK Observatory to the many astronomers and friends of the Observatory who have been kind enough to present their portraits to the library, in answer to our request. The collection is already very large, and it has not only a present but a permanent value.

Respectfully,

EDWARD S. HOLDEN.

MOUNT HAMILTON, 1896, March 21.

COMET 1855 II.

This comet was discovered by DONATI, at Florence, June 3, 1855, and independently by DIEN, at Paris, and KLINKERFUES, at Göttingen, the following night. It remained under observation only a short time, and not enough observations were obtained

* Copies may be had on application to the Secretary of the LICK Observatory.

to enable a satisfactory investigation of the elements of its orbit to be made. In all, about thirty observations were secured; only one of them was made after June 19th. That was the Berlin observation of June 30th, which gave very discordant results when compared with the ephemerides constructed from elements that were based on the earlier observations.

DONATI computed elliptic elements, from the observations of June 3d, 5th, 11th, and 17th, as follows:—

$$
\begin{array}{rl}
T & 1855 \text{ May } 30.23256 \text{ Florence M. T.} \\
\left.\begin{array}{ll}
\omega & 22^\circ\ 39'\ 5''.4 \\
\Omega & 260\ \ 15\ \ 7\ .3 \\
\pi & 282\ \ 54\ \ 12\ .7 \\
i & 156\ \ 52\ \ 51\ .6
\end{array}\right\} & 1855.0. \\
\log q & 9.7542137. \\
\log e & 9.9960301. \\
a & 62.40234.
\end{array}
$$

These elements give a periodic time of 492.95 years. If they are correct, the previous return of the comet was in 1362. The elements of the Comet of 1362 do show considerable resemblance to those above, as was pointed out by DONATI; but the elements of the Comet of 1362 were derived from the rough and uncertain Chinese observations, so that very little dependence can be placed in them.

SHULZE also computed elliptic elements of the Comet 1855 II, using the Berlin observation of June 30th as his sixth normal place. His elements gave 14¼ years as the periodic time of the comet. He did not regard his elements as satisfactory, for the second, third, and fourth normal places were not well represented. I do not know of any later investigation of these elements.

In some respects, the elements of the Comets 1855 II and 1896 *a* are similar; in others, they are quite different. Both have retrograde motion, and their inclinations and perihelion distances are nearly the same. They differ very considerably in longitude of ascending node and longitude of perihelion. They may originally have belonged to the same family of comets; they certainly are not identical.

These comets pass considerably within the orbit of *Venus*. *Venus* and *Mercury* were both in the vicinity of the Comet 1855 II at the time it was under observation. The least distance

of *Venus* was not very great, yet it does not seem probable that its perturbations could have changed the elements of the comet's orbit to any considerable extent. WILLIAM J. HUSSEY.

March 17, 1896.

MERIDIAN CIRCLE OBSERVATIONS OF COMPARISON STARS.

The following star-places have been published elsewhere, in connection with the comet observations, and are collected here, that the list of stars observed, with the numbers corresponding, may be complete. Other short lists have been printed in these *Publications* V, 32; and VII, 42.

The number of the star gives the hours, minutes, and seconds of Right Ascension for the epoch 1900. The initials refer to the observer by whom the comet comparison was made.

No.	R. A.	Decl.	Mag.	
		1894.0.		
090646	$9^h\ 6^m\ 22.73^s$	$+44°\ 44'\ 45''.3$		Comet *b*, 1893.
093751	9 37 27.77	+42 32 16 .9		R. H. T.
095954	9 59 32.98	+40 5 50 .2		
		1895.0.	Mag.	
011414	$1^h\ 13^m\ 59.10^s$	$+\ 7°\ 50'\ 35''.1$	8¼	Comet *e*, 1894.
011738	1 17 22.42	+ 8 11 19 .9	8	E. E. B.
011820	1 18 5.16	+ 8 31 45 .5	9¾	
012113	1 20 57.85	+ 8 59 4 .8	9	
		1895.0.		
003045	$0^h\ 30^m\ 29.58^s$	$+\ 5°\ 47'\ 3''.4$	8¾	Comet *a*, 1895.
				E. E. B.
		1895.0.		
013759	$1^h\ 37^m\ 43.79^s$	$+\ 4°\ 33'\ 36''.9$	9	Comet *a*, 1895.
014707	1 46 51.61	+ 6 1 57 .5	9¼	W. W. C.
014915	1 48 59.67	+ 6 32 47 .7	9	
015004	1 49 48.34	+ 6 45 20 .0	8¾	
015153	1 51 37.80	+ 6 34 38 .8	9¼	
020342	2 3 26.85	+ 7 55 34 .3	8½	
		1896.0.		
021532	$2^h\ 15^m\ 19.53^s$	$+\ 9°\ 31'\ 46''.9$	8¼	Comet *a*, 1895.
				W. W. C.
		1896.0.		
135102	$13^h\ 50^m\ 49.78^s$	$+\ 0°\ 7'\ 0''.1$	8½	Comet *c*, 1895.
135215	13 52 3.28	+ 0 10 6 .2	9	R. G. A.

R. H. TUCKER.

STATISTICS OF SOME FOREIGN AND AMERICAN UNIVERSITIE

The following very instructive table is found in *Nature* fı January 23, 1896. At the suggestion of Dr. HOLDEN, I hav copied it here, changing foreign money into American currency correcting a few errors of computation, and adding a line for thı University of California, the data for which refer to the fiscal anc academic years ending July 1, 1895.

	Gross Income.	No. of Students.	Income per Student.	No. of Professors and Assistants.	Total Salaries of Teachers.	Total Sum Spent on Library per Annum.	
						Books.	Staff.
Paris	$ 750,000	11,233	$ 67	300+	$580,000	$13,500	$20,500
Berlin	650,000	8,652	75	179+174	170,000	4,750	8,000
Vienna	545,000	6,714	81	159+190	125,000	4,650	5,400
Oxford { Univ / Colls.	318,805 / 1,250,000	3,200 Undergraduates	99 / 391	70+	?	26,190	23,810
Cambridge { Univ. / Colls.	327,750 / 1,410,000	2,900 Undergraduates	113 / 486	80+	?	10,200	20,000
Harvard	1,300,000	3,783	344	149+188	505,000	25,000	21,000
Leipzig	450,000	2,957	152	134+65	230,000	12,500	10,000
Edinburgh	440.710	2,924	151	90+	240,000	7,000	5,060
London	105,000	2,225	47	....	.....	500	?
Cornell	525,000	1,686	311	77+80	270,000	$38,000	
Padua	134,000	1,672	80	62+60	100,000	2,000	5,000
Graz	99,000	1,562	64	83+28	50,000	$11,000	
Upsala	200,000	1,495	134	122	121,500	6,000	
Bologna	150,000	1,457	103	70+81	100,000	2,000	3,400
Heidelberg	192,000	1,428	134	96+25	115.000	4,000	?
Tokio	350,000?	1,396	251?	123+31	125,000	?	?
Tübingen	225,000	1,262	178	69+15	100,000	3,500	?
Dublin (Trinity College)	350,000	1,124	311	35+	?	?	?
* University of California	298,900	1,124	266	42+68	175,900	3.550	4,38
Strassburg	250,000	1,030	243	88+32	130,000	14,750	14,00
Greifswald	195,000	891	219	64+22	65,000	10,000	5,00
† Zürich	150,000	822	182	61+56	47.500	$5.750	
Leyden	311,000	815	382	50+ ?	165,000	3,900	2,22
Königsberg	245,000	756	324	70+32	75,000	6,850	6,50
Giessen	190,000	598	318	55+8	65,000	4,500	2,85
Johns Hopkins	175,000	589	297	42+42	?	?	?
Rostock	80,000	420	190	42+3	39,500	5,150	2,00
St. Andrew's	59,860	199	301	15+4	50,000	$3,150	

* Not including the LICK Observatory and the Colleges of Art, Law, Medicine, Dentistı and Pharmacy, which have a teaching force of about forty seven Professors and sevent eight Assistants, and an attendance of 663 students.

† Not including the Polytechnicum, with its 1235 students.

ROBERT G. AITKEN.

INDEX TO THE VIERTELJAHRSSCHRIFT DER ASTRONOMISCHEN GESELLSCHAFT, BY GENERAL ALEXIS VON TILLO.

A very much-needed index to the first twenty-five volumes of the V. J. S. *der Astronomischen Gesellschaft* has just been made by General VON TILLO, and issued by the Society. E. S. H.

ELEMENTS OF COMET *PERRINE*, 1896 *a*.

From Mr. PERRINE'S observation at the time of discovery, the morning of February 15th, and my observations of the mornings of February 20th and 25th, I have computed the following elements of Comet 1896 *a*:—

$$
\begin{array}{ll}
T & 1896 \text{ Jan. } 31.77508 \text{ Gr. M. T.} \\
\omega & \left.\begin{array}{l} 358^\circ\ 21'\ 24''.7 \\ \Omega\ 208\ \ 52\ \ 26\ .1 \\ \pi\ 207\ \ 13\ \ 50\ .8 \\ i\ 155\ \ 45\ \ 37\ .2 \end{array}\right\} 1896.0. \\
\log q & 9.768844.
\end{array}
$$

$$(O-C):\quad \Delta\lambda' \cos \beta' = +\, 2''.0; \quad \Delta\beta' = -\, 2''.0;$$

$$\frac{\tan(\lambda' - \Theta')}{\sin \beta'} = -\, 1.066.$$

An ephemeris has been computed from these elements, and the observations made in March show the comet to be following it very closely. The brightness of the comet is diminishing rapidly, and it will probably not remain visible more than two or three months longer. W. J. HUSSEY.

March 17, 1896.

CHARTS OF FAINT STARS FOR MAGNITUDE COMPARISON (THIRD SERIES).

The adjoining four small charts close the set of twelve, as originally planned for the thirty-six-inch telescope, furnishing one at about each two hours of Right Ascension. Their completion has been delayed, owing to the demands of other work, on the relatively few good nights that occur at the season of year when these are in position. In order to finish them, some of the observing has been done at rather large zenith distance; one of them is at fifty degrees zenith distance when on the meridian.

Still the charts represent the reach of the thirty-six-inch tele-

scope under average conditions; on the best nights, and close to the zenith, undoubtedly some few additional stars would be shown. As in the series previously published,* the charts follow some bright star by two minutes, and are four minutes long in Right Ascension by ten minutes wide in Declination, extending five minutes each side of the bright star, north and south.

These are located:

			R. A.	Decl.
I	follows	α *Piscium*	$1^h\ 56^m$	$+\ 2°\ 15'$
II	"	γ *Eridani*	3 53	− 13 49
III	"	ε *Orionis*	5 31	− 1 16
IV	"	ε *Hydræ*	8 41	+ 6 49

The set of charts was first prepared at the Harvard College Observatory, and stars down to the fifteen magnitude are represented by the observing done there.

With the twenty-six-inch telescope at Washington some additional stars were plotted, and in one of the charts the sixteenth magnitudes are completely represented.

With the thirty-six-inch telescope the greater proportion of stars added have been of the lowest class, sixteenth and seventeenth magnitudes, but a number have been classed in the next higher, fourteen and fifteen.

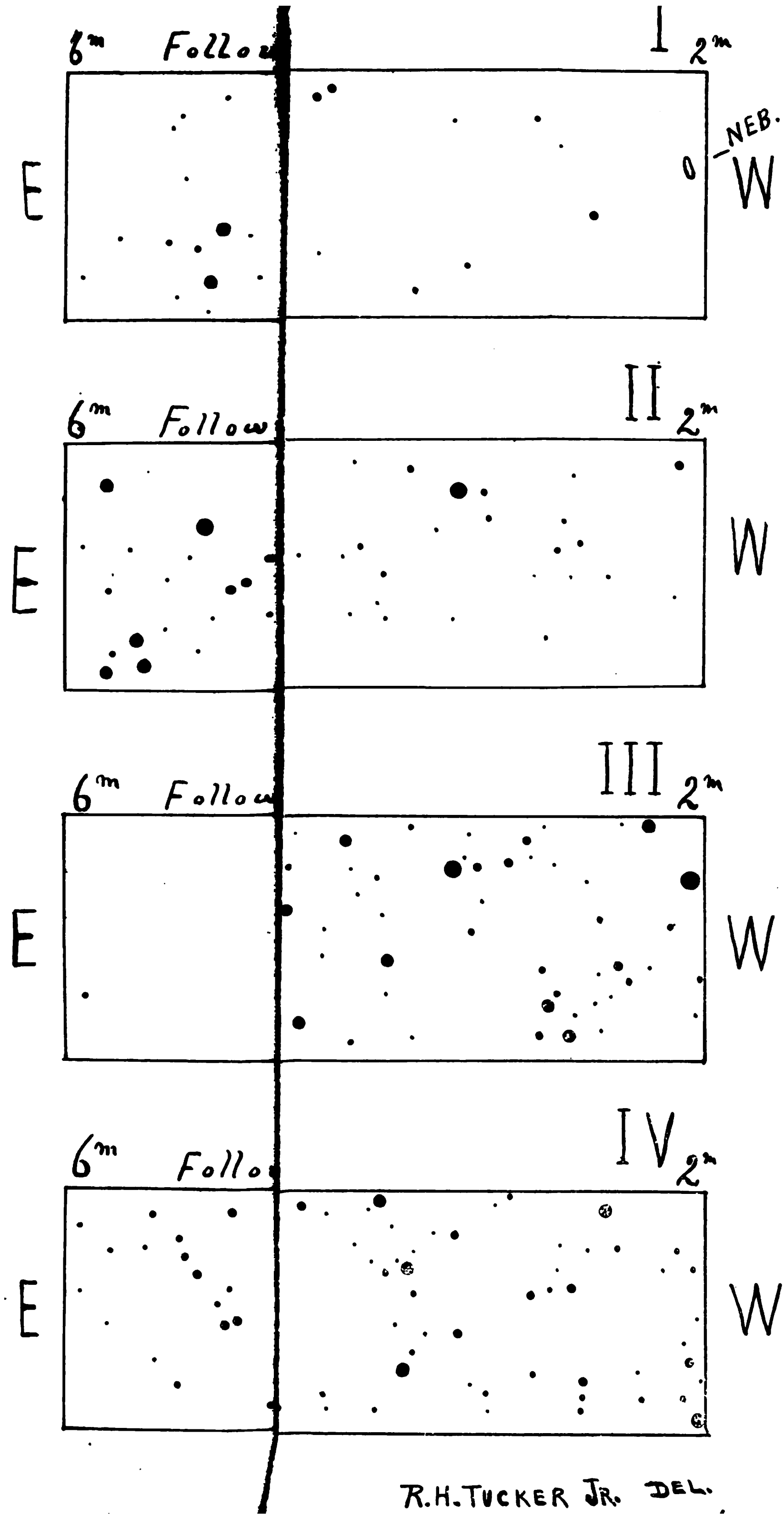
In this series of four, two hundred new stars have been plotted with the thirty-six-inch telescope, and one hundred and seventy-four have been identified of those previously noted. They fall, respectively, within the following classes:

1	9 magnitude and brighter,	6 stars
2	10 and 11 magnitude,	33
3	12 and 13 "	54
4	14 and 15 "	118
5	16 and 17 "	163
	and one nebula.	374 stars

These classes, used in the charts previously published, may be taken to represent the reach of telescopes of one, three, six, fifteen, and thirty-six inches.

The combined set of twelve charts covers an area of two square degrees. Since they are spaced at nearly equal intervals, in a girdle about the sky, they probably present, roughly, something

* *A. S. P.*, Vol. V, 32, and Vol. VI, 37.



R. H. TUCKER JR. DEL.

of the general distribution of the stars. They present a great variety, ranging in number of stars from 29 to 459; the average being 116.

In some, there are evident tendencies towards clustering; others have a fairly uniform distribution. In III of this latest series, there is a sudden diminution in the last two minutes, forming a decided blank, a feature of the sky which is familiar to all who have had large regions under continuous observation.

The total number of stars charted with the thirty-six-inch telescope is 1396; about 700 to the square degree. While this is not sufficient basis for expanding to the whole sky, it may serve to give an idea of proportion. The total count gives the distribution in classes, as above:

1	16	stars
2	91	
3	192	
4	327	
5	770	

The total number of stars included, down to each type, is a test that has been quite thoroughly made for the brighter part of the magnitude scale. The various Uranometries and the several sections of the *Durchmusterung* have furnished the material for such count.

For these faint stars, in this limited area,

1	per	cent.	are	9	magnitude,	or	brighter.
8	"	"	"	11	"	"	"
21	"	"	"	13	"	"	"
45	"	"	"	15	"	"	"

With 700 stars to the square degree, there would be about

29	million	to	the	17	magnitude.
13	"	"	"	15	"
6	"	"	"	13	"
2	"	"	"	11	"

and 300,000 of the 9 magnitude.

These figures are not far from estimates which place the ninth-magnitude stars between two and three hundred thousand; while the estimate of the photographic chart to the eleventh magnitude is about two millions.

The ratio of increase in numbers, which has been found to hold good down to the ninth magnitude, breaks down here, as

the fainter stars are included. Thus, expressing the total number of stars down to the magnitude m inclusive, by the well-known form $a\ b^m$, b has been found to be 3.9 down to the ninth magnitude.

It is also true for the lower grade of the Cordoba *Durchmusterung*, as that includes a large proportion below the tenth magnitude. In this count of fainter stars, b drops at once below 3: and averages 1.5 from 11 magnitude to 17 magnitude. If the ratio in the number of fainter stars fails to increase, it would appear to indicate that our telescopes are reaching the confines of the stellar system. And that in place of extending to greater depths, the smaller or less bright objects, intrinsically, within the limits already explored, are being brought within our ken. No hypothesis of this character admits of proof at present. If the stars are, in general, uniformly distributed, and if their brightness depends mainly upon their distance from us, the number of fainter stars should keep up the ratio.

But we know that the brightest stars are not universally the nearest; and uniform distribution cannot be proved. There is undoubtedly great variety of size, and probably of intrinsic brightness. Should a count of faint stars, based upon more complete material, fail to show more of an increase in number than could fairly be assumed as due to the variety of size and brilliancy of the stars in regions already known, it would seem probable that we are penetrating no farther into space.

R. H. TUCKER.

15-INCH REFRACTOR FOR THE OBSERVATORY OF KOENIGSBERG.

A private letter from Professor HERMANN STRUVE, Director of the Observatory, notifies that there is a prospect that the Koenigsberg Observatory may soon possess a refractor of fifteen inches aperture.

E. S. H.

SUSPENSION OF THE "AMERICAN METEOROLOGICAL JOURNAL."

The editors of the *American Metereological Journal* announce that the publication will cease with the number for April, 1896, (which completes volume XII). The *Journal* has been carried on at a loss (which has been borne by the editors) and the present

step has been decided upon because there seems to be no present prospect that the periodical will be self-supporting.

The *Journal* has been of distinct benefit to science in many respects and a credit to its editors and to the United States. Its suspension is very regrettable. But it is a wise step. There is no reason why private persons should bear the serious expense of producing it. The successive editors deserve, and will receive, the thanks of their fellow-men of science. E. S. H.

Errata in Star Catalogues.

BD. — 6° 5269. This star is stated to be in Weisse's Catalogue of Bessel's stars, but is not found there.

Weisse's Bessel I, 19^h 1088.

Runkle in his list of errata published in the *Astronomical Journal*, Vol. III, page 115, changes the Declination of this star. I used it as a comparison star in observing Comet *c*, 1895, and find that its place as given in Weisse's catalogue agrees with the Munich reductions of Lamont's observations of this star, and also with Bessel's original zone observations. Hence, Runkle's correction seems to be erroneous.

C. D. Perrine.

Lick Observatory, March 21, 1896.

Elements of Comet *c*, 1895, (Perrine).

The following elements are based upon Mr. Perrine's observations of November 17 and December 7, 1895, and March 10, 1896, at Mount Hamilton.

$$T = 1895, \text{ Dec. } 18.32670 \text{ Gr. M. T.}$$

$$\left.\begin{aligned} \omega &= 272^\circ\ 40'\ 23''.4 \\ \Omega &= 320\ \ 30\ \ 47\ .6 \\ i &= 141\ \ 36\ \ 39\ .5 \end{aligned}\right\} 1896.0$$

$$\log q = 9.283259$$

$$\begin{aligned} x &= r\,[9.963187] \sin(\ 35^\circ\ 31'\ 42''.1 + v) \\ y &= r\,[9.996428] \sin(128\ \ 42\ \ \ 5\ .4 + v) \\ z &= r\,[9.618080] \sin(235\ \ \ 5\ \ 54\ .1 + v) \end{aligned}$$

Residuals for the middle place (o — c)

$$\cos\beta\,\Delta\lambda = + 1''.5 \qquad \Delta\beta = + 1''.9.$$

R. G. Aitken.

Lick Observatory, March 24, 1896.

PROGRESS OF WORK ON THE CROSSLEY DOME.

The present winter has been a very open one, and it has been possible to do a considerable amount of work on the CROSSLEY Dome by choosing favorable days. A solid brick pier has been built to receive the iron mounting. A new iron base-plate to receive the former base-plate has been cast, and is now in place on the pier. Its function is to change the inclination of the polar-axis from that at Halifax (53° 40′) to that required at Mt. Hamilton (37° 20′). It was made in San Francisco, under the direction of Messrs. PERCY & HAMILTON, architects. It weighs about 1700 pounds.

The track is in place, bolted to the stone cap, and level. The rolling gear and bottom ring of the dome were placed on the track March 13th. The two main girders and several of the smaller ribs are now (March 21st) in place. In a few days the workmen will commence to rivet the covering on the ribs. In a few weeks all the heavy work of erecting the dome and mounting will be finished.

It is worthy of note that the large derrick and all the necessary machinery have been made by the mechanics of the Observatory (Mr. MACDONALD, machinist; Mr. BANE, carpenter,) and that the whole business of handling the heavy pieces and securing them in place has been done by the Observatory workmen, without employing any mechanics from the outside.

EDWARD S. HOLDEN.

MT. HAMILTON, March 21, 1896.

HONOR CONFERRED ON PROFESSOR HOLDEN.

The Minister of Foreign Affairs of the Republic of Venezuela has transmitted to the Director of the LICK Observatory the diploma of the Order of BOLIVAR ("Orden del Busto del Libertador"), III Class, conferred by the President of the Republic, February 24, 1896, for services to science. This order was founded by the Republic of Peru in 1825, and adopted by Venezuela in 1854. The decoration of the III Class is bestowed upon Presidents of States, and presiding officers of their legislative assemblies; on the Rectors of the Universities; the Judges of High Courts of Justice, etc.

Minutes of the Meeting of the Board of Directors, held in the Rooms of the Society, March 28, 1896, at 7:30 P. M.

President BURCKHALTER presided. A quorum was present. The minutes of the last meeting were read and approved. The following members were duly elected:

List of Members Elected March 28, 1896.

Mr. E. F. BIGELOW	5 Waverly Avenue, Portland, Conn.
Mr. HENRY J. CROCKER	508 California St., S. F., Cal.
LIBRARY OF THE MECHANICS' INSTITUTE .	31 Post St., S. F., Cal.
Mr. FRED. G. PLUMMER	Tacoma, Washington.

Mr. W. H. DEVINE, of Nagasaki, and Mr. A. E. KENNELLY, of Philadelphia, were elected to life membership.

The Library Committee recommended that copies of the Library Catalogue, No. 18, be sent to members who have joined the Society since October, 1891; and that a supplement, comprising the bound volumes added to the library since that date, be published and sent to all members.

Also, that supplementary catalogues be published in future, from time to time, according to the judgment of the Library Committee.

The following resolutions were, on motion, adopted:

Resolved, That the Astronomical Society of the Pacific will exchange its *Publications* for the journals named below, which are regularly sent to the library; and that the Committee on Publication is authorized to carry these exchanges into effect: *The Astrophysical Journal*, Chicago, Illinois; *The Observatory*, Greenwich, England; *The Observer*, Portland, Connecticut; *Sirius*, Cologne, Germany.

Resolved, That the Committee on Publication is authorized to send the *Publications* A. S. P. for review, to the following California periodicals, namely: The *Overland Monthly*, *Call*, *Chronicle*, *Examiner*, of San Francisco; the *Tribune*, of Oakland; the *Times*, of Los Angeles; the *Mercury*, of San Jose; the *Record-Union* of Sacramento.

WHEREAS, The library of the Mechanics' Institute, San Francisco, has become a member of the Society, to date from March 28, 1896,

Resolved, That this name be transferred from the list of corresponding institutions to the list of active members.

Adjourned.

MINUTES OF THE ANNUAL MEETING OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC, HELD IN THE LECTURE HALL OF THE CALIFORNIA ACADEMY OF SCIENCES, MARCH 28, 1896.

The meeting was called to order by President BURCKHALTER. The minutes of the last meeting were approved.

The Secretary read the names of new members duly elected at the Directors' meeting.

The following papers were presented:

1. The Address of the retiring President, by Mr. CHARLES BURCKHALTER, of Oakland.
2. Reports of Committees: On the Comet-Medal; on Nominations; on Auditing; and Annual Report of the Treasurer.
3. Personal Equation, by Mr. R. H. TUCKER, of Mount Hamilton.
4. Ephemeris of Comet *c*, 1895, by Mr. C. D. PERRINE, of Mount Hamilton.
5. Planetary Phenomena for May and June, 1896, by Professor M. MCNEILL, of Lake Forest.
6. Telegraphic Announcements of Astronomical Discoveries, by Dr. EDWARD S. HOLDEN, of Mount Hamilton.
7. Astronomical Observations in 1894 and 1895 by Mr. TORVALD KÖHL, of Odder, Denmark.
8. A List of Some Reported Earthquakes on the Pacific Coast, by Mr. F. G. PLUMMER, of Tacoma.
9. Observations of *Mira Ceti*, 1895–96, by Miss ROSE O'HALLORAN, of San Francisco.

The Committee on Nominations reported a list of names proposed for election as Directors as follows: Messrs. EDWARDS, HOLDEN, HUSSEY, MOLERA, Miss O'HALLORAN, Messrs. PARDEE, PERRINE, PIERSON, STRINGHAM, VON GELDERN, ZIEL.

For Committee on Publication: Messrs. HOLDEN, BABCOCK, AITKEN.

Messrs. CUSHING and PERCY were appointed as tellers. The polls were open from 8:15 to 9:00 P. M., and the persons above named were duly elected.

REPORT OF THE COMMITTEE ON THE COMET-MEDAL, SUBMITTED MARCH 28, 1896.

This report relates to the calendar year 1895. The comets discovered in 1895 have been:

Comet *a:* (unexpected comet, 1895, II), discovered by Dr. L. SWIFT, on August 20th.

Comet *b:* (FAYE'S periodic comet, 1896, ——), discovered by M. JAVELLE, at Nice, September 26th.

Comet *c:* (unexpected comet, 1895, IV), discovered by Mr. C. D. PERRINE, at Mount Hamilton, November 20th.

Comet *d:* (unexpected comet, 1895, III), discovered by Mr. W. R. BROOKS, at Geneva, N. Y., November 21st.

The Comet-Medal has been awarded to the discoverers of Comets *a*, *c*, and *d*, in accordance with the regulations.

Respectfully submitted,

EDWARD S. HOLDEN,
J. M. SCHAEBERLE,
WILLIAM J. HUSSEY,
Committee on the Comet-Medal.

The Treasurer submitted his Annual Report, as follows:

ANNUAL STATEMENT OF THE RECEIPTS AND EXPENDITURES OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC FOR THE FISCAL YEAR ENDING MARCH 28, 1896.

GENERAL FUND.

Receipts.

Cash Balance March 31, 1895		$ 406 83
Received from dues	$1,911 54	
" " sale of publications and reprints	41 75	
" " sale of stationery	1 90	
" " advertisements	85 00	
" " Security Savings Bank (interest)	04	
" " Life Membership Fund (interest)	60 48	
	$2,100 71	
Less transfer to Life Membership Fund	350 00	1,750 71
		$2,157 54

Expenditures.

For publications	$ 865 00	
" general expenses	711 81	$1,576 81
Cash Balance March 28, 1896		580 73
		$2,157 54

LIFE MEMBERSHIP FUND.

Cash Balance March 31, 1895	$1,350 61	
Received from General Fund	350 00	
" " interest	60 48	
	$1,761 09	
Less Interest transferred to General Fund	60 48	
Cash Balance March 28, 1896		$1,700 61

DONOHOE COMET-MEDAL FUND.

Cash Balance March 31, 1895	$ 644 61	
Interest	29 71	
Cash Balance March 28, 1896		$ 674 32

ALEXANDER MONTGOMERY LIBRARY FUND.

Cash Balance March 31, 1895	$1,793 83	
Interest	82 45	
	$1,876 28	
Expended for maps and binding	18 90	
Cash Balance March 28, 1896		$1,857 38

FUNDS.

General Fund. Balance on deposit with Donohoe-Kelly Banking Co.	$ 278 76	
" " Balance on deposit with Security Savings Bank	301 97	$ 580 73
Life Membership Fund. Balance on deposit with San Francisco Savings Union		1,700 61
Donohoe Comet-Medal Fund. Balance on deposit with San Francisco Savings Union		674 32
Alexander Montgomery Library Fund. Balance on deposit with San Francisco Savings Union	$ 891 40	
Alexander Montgomery Library Fund. Balance on deposit with German Savings and Loan Society	965 98	1,857 38
		$4,813 04

SAN FRANCISCO, March 28, 1896. F. R. ZIEL, *Treasurer.*

The Committee appointed to audit the Treasurer's accounts reported as follows, and the report was, on motion, accepted and adopted, and the Committee discharged:

To the President and Members of the Astronomical Society of the Pacific:

GENTLEMEN—Your Committee appointed to audit the accounts of the Treasurer for the fiscal year ending March 28, 1896, have made a careful examination and find same to be correct. We take pleasure in adding that the books of the Society are neatly and carefully kept, and the business system excellent.

Yours respectfully,

D. F. TILLINGHAST, *Chairman*
CHAS. B. HILL,
L. C. MASTEN.

President BURCKHALTER then read his Annual Address.

Mr. TUCKER read a paper on Personal Equation.

The following resolution, was on motion, adopted:

Resolved, That all the acts appearing in the minutes of the meetings of the Board of Directors of this Society, as having been done by said Board during the past fiscal year, are here now by this Society approved and confirmed.

The thanks of the Society were returned to the CALIFORNIA ACADEMY OF SCIENCES for the use of the lecture hall.

Adjourned.

MINUTES OF THE MEETING OF THE BOARD OF DIRECTORS OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC, HELD IN THE ROOMS OF THE SOCIETY, MARCH 28, 1896, AT 10 P. M.

The new Board of Directors was called to order by Mr. BURCKHALTER. A quorum was present. The minutes of the last meeting were approved.

The business in hand being the election of officers for the ensuing year, the following officers—having received a majority of the votes cast—were duly elected:

President: Mr. W. J. HUSSEY.
First Vice-President: Mr. E. J. MOLERA.
Second Vice-President: Mr. E. S. HOLDEN.
Third Vice-President: Mr. O. VON GELDERN.
Secretaries: Messrs. C. D. PERRINE and F. R. ZIEL.
Treasurer: Mr. F. R. ZIEL.
Committee on the Comet-Medal: Messrs. HOLDEN (*ex-officio*), SCHAEBERLE, CAMPBELL.

The President was authorized to appoint the various Standing Committees of the Directors, and accordingly made the following selections:

Finance Committee: Messrs. VON GELDERN, PIERSON, STRINGHAM.
Library Committee: Miss O'HALLORAN, Messrs. MOLERA and BURCKHALTER.
The Committee on Publication is composed of:
Messrs. HOLDEN, BABCOCK, AITKEN.

It was, on motion:

Resolved, That the Directors of the Astronomical Society of the Pacific extend to Mr. BURCKHALTER their thanks for his valuable services as President of the Society.

Adjourned.

OFFICERS OF THE SOCIETY.

W. J. Hussey (Lick Observatory), ... *President*
E. J. Molera (606 Clay Street, S. F.) . . . . } *Vice-Presidents*
E. S. Holden (Lick Observatory), ... }
O. von Geldern (819 Market Street, S. F.) . . . . . }
C. D. Perrine (Lick Observatory), ... *Secretary*
F. R. Ziel (410 California Street, S. F.), ... *Secretary and Treasurer*

Board of Directors—Messrs. Edwards, Holden, Hussey, Molera, Miss O'Halloran, Messrs. Pardee, Perrine, Pierson, Stringham, von Geldern, Ziel.

Finance Committee—Messrs. von Geldern, Pierson, Stringham.

Committee on Publication—Messrs. Holden, Babcock, Aitken.

Library Committee—Miss O'Halloran, Messrs. Molera, Burckhalter.

Committee on the Comet-Medal—Messrs. Holden *(ex-officio)*, Schaeberle, Campbell.

OFFICERS OF THE CHICAGO SECTION.

Executive Committee—Mr. Ruthven W. Pike.

OFFICERS OF THE MEXICAN SECTION.

Executive Committee—Messrs. Camilo Gonzalez, Francisco Rodriguez Rey.

NOTICE.

The attention of new members is called to Article VIII of the By-Laws, which provides that the annual subscription, paid on election, covers the *calendar* year only. Subsequent annual payments are due on January 1st of each succeeding calendar year. This rule is necessary in order to make our book-keeping as simple as possible. Dues sent by mail should be directed to Astronomical Society of the Pacific 819 Market Street, San Francisco.

It is intended that each member of the Society shall receive a copy of each one of the *Publications* for the year in which he was elected to membership and for all subsequent years. If there have been (unfortunately) any omissions in this matter, it is requested that the Secretaries be at once notified, in order that the missing numbers may be supplied. Members are requested to preserve the copies of the *Publications* of the Society as sent to them. Once each year a title-page and contents of the preceding numbers will also be sent to the members, who can then bind the numbers together into a volume. Complete volumes for past years will also be supplied, to members only, so far as the stock in hand is sufficient, on the payment of two dollars to either of the Secretaries. Any non-resident member within the United States can obtain books from the Society's library by sending his library card with ten cents in stamps to the Secretary A. S. P., 819 Market Street, San Francisco, who will return the book and the card.

The Committee on Publication desires to say that the order in which papers are printed in the *Publications* is decided simply by convenience. In a general way, those papers are printed first which are earliest accepted for publication. It is not possible to send proof sheets of papers to be printed to authors whose residence is not within the United States. The responsibility for the views expressed in the papers printed rests with the writers, and is not assumed by the Society itself.

The titles of papers for reading should be communicated to either of the Secretaries as early as possible, as well as any changes in addresses. The Secretary in San Francisco will send to any member of the Society suitable stationery, stamped with the seal of the Society, at cost price, as follows: a block of letter paper, 40 cents; of note paper, 25 cents; a package of envelopes, 25 cents. These prices include postage, and should be remitted by money-order or in U. S. postage stamps. The sendings are at the risk of the member.

Those members who propose to attend the meetings at Mount Hamilton during the summer should communicate with "The Secretary Astronomical Society of the Pacific" at the rooms of the Society, 819 Market Street, San Francisco, in order that arrangements may be made for transportation, lodging, etc.

PUBLICATIONS ISSUED BI-MONTHLY.

(February, April, June, August, October, December.)

PUBLICATIONS

Astronomical Society of the Pacific.

VOL. VIII. SAN FRANCISCO, CALIFORNIA, APRIL 1, 1896. No. 49.

A CIPHER-CODE FOR ASTRONOMICAL MESSAGES.*

BY EDWARD S. HOLDEN.

PRINCIPLES OF THE CIPHER-CODE.

Table I consists of 510 cipher-words of three letters each; as *Hil*= 100. When a word of three letters occurs in a message, it signifies a *local date*; as *Hil*= 100th day of the year = April 10 (in common years, April 9 in leap-years). The words of Table I are usually employed as prefixes to one of the five-letter affixes of Table II; as *Hilofant*= 10072, making a *number*-word. In certain (specified) cases these numbers signify degrees and minutes of *arc*; as *Hiladize*= 100° 05′ (the prefix always gives the degrees; the affix, the minutes). In certain other (specified) cases, the number-words are used to denote an accurate date (always in Greenwich days and hundredths of a day); as *Rokalone*= $286^d.15$ = October 13^d 3^h 36^m G. M. T. (in any common year). See Tables III and V.

All number-words have eight letters. The use of Table III is obvious. Table IV contains in the second column certain arbitrary cipher-words (each one of six letters and of two syllables); and, in the third column, certain phrases or sentences, each corresponding to a single cipher-word. The third column of Table IV is essentially a copy of Part II of the "Science-Observer Code." The whole table contains more phrases than I should myself select, were the work to be done *ab initio*. Table V will be found convenient.

Any expert in cipher-codes will remark various precautions against mistakes of eye and ear which have been adopted in what follows. They have been suggested by experience in the use of the "Science-Observer Code" for transmitting astronomical telegrams, and of other codes for other uses.

I have to thank my colleagues at Mount Hamilton for valued advice and assistance in preparing these tables.

The great merit of the "Science-Observer Code" is in its system of

*See *Publications* A. S. P., Vol. VIII, page 64.

control-words, or checks. The present code contains the same checks, and has the additional advantages (among others):

First, that all the words of the telegram contain either three, six, or eight letters (except in the case of proper names), and thus that the cipher-words are short, and of uniform lengths.

Second, that all local dates (month and day only) are expressed by words of three letters.

Third, that all arbitrary cipher-phrases are denoted by words of six letters.

Fourth, that all accurate dates (G. M. T.), and all numbers, are expressed by cipher-words of eight letters.

The system of cipher adopted enables one to replace the first 203 (quarto) pages of the "Science-Observer Code" by our Tables I, II, III, which are printed on three (octavo) pages, thus saving much needless turning of leaves. The rest of the present code is simply an adaptation of the "Science-Observer Code." Members of the Astronomical Society of the Pacific, and others, may find the present code convenient for communications between themselves, and with the LICK Observatory.

GENERAL RULES FOR ASTRONOMICAL TELEGRAMS.

Dates.— When the date is given to the nearest day only, *by a three-letter word from Table I*, the date is always the *local* date of the observer (not of the person who sends the telegram). This avoids ambiguities. When the date is given to the decimal of a day, *by a compound-word from Tables I and II*, it is always expressed in Greenwich mean days and decimals. All days begin at noon.

Right Ascensions, differences in R. A., motions in R. A., are always expressed in *time*, (thus avoiding one of the chief annoyances in the use of the "Science-Observer Code." See its page 10, word 5, for example).

Declinations from +90° to —90° are always expressed as *North-polar-distances.*

Positions are understood to be referred to the apparent equinox of the date (except when otherwise especially noted in the precepts).

N. B.—Always send the full complement of words, filling (otherwise) blank spaces by the words *Baf* (Table I), *nicht* (Table II), or *voidness*, *zerotion*, etc.

The code is particularly useful in sending certain standard forms of telegrams (explained in what immediately follows), though it can be employed for any astronomical news. It will give little trouble to English-speaking folk; and can be used by Europeans. Finally, it is to be recollected that no cipher-telegram is suitable to replace a letter, or to convey very complex messages; and, therefore, the telegrams must be made short and correct, and information that can wait (as accurate ephemerides, etc.) transmitted by letter.

It may prevent mistakes to write five figures to correspond to every number-word; as, 00172 for 172, 01724 for 1724, 135° 05′ for 135° 5′, etc.

SEVENTEEN-WORD DISPATCH.

GIVING ELEMENTS AND EPHEMERIS. (See Table IV, No. 51051).

Word No. 1 = Time of perihelion passage = T.
Word No. 2 = Distance of perihelion from node = $\omega = \pi - \Omega$.
Word No. 3 = longitude of node = Ω.
Word No. 4 = inclination (which may range from 0° to 180°) = i.
N. B.—The elements 2, 3, 4 are referred to the mean equinox of the beginning of the year.
Word No. 5 = perihelion distance = q (not log q).
Word No. 6 = control-word = $\frac{1}{4}$ the sum of the five number-words 1, 2, 3, 4, 5.
Word No. 7 = first date of the ephemeris (*Greenwich date*), and the *light* for that date.
Word No. 8 = First R. A.
Word No. 9 = First N. P. D.
Word No. 10 = Second R. A.
Word No. 11 = Second N. P. D.
Word No. 12 = Third R. A.
Word No. 13 = Third N. P. D.
Word No. 14 = Fourth R. A.
Word No. 15 = Fourth N. P. D.

Four-day intervals are to be understood in the ephemeris. Positions refer to Greenwich mean midnight.

Word No. 16 = last date of ephemeris and *light* for that date.
Word No. 17 = *local mean* dates of the observations on which the elements depend. (See Table IV, No. 51122).

Detail of Seventeen-Word Dispatch.

Word No. 1.—The time of perihelion passage is given by an eight-letter number-word (made up of a prefix from Table I and of an affix from Table II). This gives the day of the year and the hundredths of a day. Thus T = Nov. $7^d.91$ G. M. T. = $311^d.91$ is expressed by *Sinugale* (see Tables I and III).

Word No. 2.—Distance of perihelion from node, = $\omega = \pi - \Omega$. This is expressed by an eight-letter number-word in degrees and minutes. Table I gives the degrees, Table II the minutes. Thus, $\omega = 99° \, 34'$ is expressed by *Hikelope*.

Word No. 3.—Longitude of node, in arc, as for word No. 2. Thus, $\Omega = 300° \, 50'$ is *Safilade*.

Word No. 4.—Inclination = i, in arc, as above. Thus, $i = 7° \, 22'$ is *Bazaside*.

Word No. 5.— Perihelion distance = q. This element is to be expressed in units of the *fourth* decimal place. Thus, $q = 1.1049$ is *Horijest*.

Word No. 6.—This word is inserted to enable the receiver of the message to be certain that the foregoing elements have been correctly received (and translated). Errors in transmission can sometimes be corrected by its aid. It is determined by adding all the numbers corresponding to words 1, 2, 3, 4, 5, and by dividing their sum by 4.

N. B.—In making this addition, be careful to express such angles as $135° 5'$ in the form 135.05, etc.

Example: T = 311 91.
ω = 99 34.
Ω = 300 50.
i = 7 22.
q = 110 49.
Sum = 829 46.
¼ sum = 207 36, and the control-word is *Lunendow*.

Word No. 7.—The first date for the ephemeris, and the light for that date. This will be expressed by a number-word of eight letters, as *Pinative* = 25124. The affix (24) gives *the Greenwich day* corresponding to the first date of the ephemeris. The month itself must be inferred from the date of the telegram. If this is dated May 20, the first date of the ephemeris is May 24. The *light* of the comet at discovery is always assumed to be 1.0. The *prefix* of word No. 7 gives the *light* on the first date of the ephemeris, expressed in units and *tenths* (not hundredths). Thus, B = 25.1.

N. B.—If the date of discovery is not known, the light of the comet at the first date of the ephemeris is to be assumed to be 1.0, and in this case (and in one other case *only*) the prefix to Word No. 7 will be *Bil*. The other (very improbable) case is when the comet does not change its brilliancy between discovery and the first date of the ephemeris.

Word No. 8.—First R. A. of ephemeris. This will be expressed by a single number-word of eight letters; as *Moyirize* = 23162, which is to be read as $23^h\ 16^m.2$; *i. e.*, the three figures on the right *always* express minutes and tenths of minutes of *time*, and the remaining figures, hours of R. A. ($0^h\ 7^m.0$ should be written 00070 = *Bafocean;* $11^h\ 0^m.0$ should be written 11000 = *Hornicht*).

$0^m.1$ is the most convenient unit for R. A. positions in an ephemeris sent *by telegraph*. The object will always fall in the field of the eye-piece employed for comets. It is entirely unnecessary to give the R. A. to 1' of arc.

Word No. 9.—First N. P. D. This will be given by a number-word of eight letters, which corresponds to degrees and minutes of arc. Thus, $\delta = 46° 56'$, or N. P. D. $= 43° 04'$ = *Ditadieu*. ($\delta = -47° 51'$ = N. P. D. $137° 51'$ = *Jolilant*).

Word No. 10.—Second R. A.
Word No. 11.—Second N. P. D.
Word No. 12.—Third R. A.
Word No. 13.—Third N. P. D.
Word No. 14.—Fourth R. A.
Word No. 15.—Fourth N. P. D.

Each will be expressed by a number-word of eight letters, precisely as for words No. 8 and No. 9, corresponding to *four-day* intervals in the ephemeris.

Word No. 16.—Last date and *light* of the ephemeris. This, like Word No. 7, will be expressed by a number-word of eight letters; as *Sipadize* = 31205. The day of the month is 05, and must correspond (see Word No. 7) to June 5, since the last date of the ephemeris is twelve days later than the first (May 24), which constitutes a rough control. B = 31.2.

Word No. 17.—Local mean date of first observation (*prefix*), and interval in days between the first and second observations (first figure of *affix*), and between the second and third observations (second figure of *affix*). The cipher-word will be a number-word of eight letters; as *Juneting* = 14741. The first observation was on May 27 (147^d), if the year was not a leap-year; the second observation was four days later (May 31); the third observation was one day later (June 1).

N. B.—Should any *interval* be *greater than nine days*, write the word *nicht* as the affix. Thus, *Junnicht* = 14700 indicates that the first observation upon which the orbit is based was made on May 27 (147^d), and that at least one of the intervals between the first and second, and second and third observation, is greater than nine days—and thus, that the ephemeris is likely to be accurate. See Table IV, No. 51122.

Example: Elements and ephemeris of Comet *Pechule*, 1880, (from "Science-Observer Code," page 8). N. B.—1880 is a leap-year.

	ELEMENTS.	I.	II.
1.	T=Nov. 9.62 G. M. T. =	314 62 = *Sod-irize*,	(Manceps).
2.	$\omega = 13° \ 21$	013 21 = *Bit-aship*,	(Aguijoso).
3.	$\Omega = 249° \ 39'$	249 39 = *Pik-eroon*,	(Hellhag).
4.	$i = 60° \ 41'$	060 41 = *Faf-eting*,	(Bifidate).
5.	$q = 0.6775$	067 75 = *Faz-ogive*,	(Bostezante).
	Sum,	705 38	
6.	¼ sum,	176 34 = *Kul-elope*,	(Efforts).

	EPHEMERIS.	I.	II.
7.	Jan. 7 = 7; Brightness = 1.0,	01007 = *Bil-aflow*,	(Breastwork).
8.	R. A. $20^h \ 32^m.4$	20324 = *Lud-ative*,	(Macropod).
9.	N. P. D. $67° \ 10'$	06710 = *Faz-aglow*,	(Bordadora).
10.	R. A. $20^h \ 49^m.9$	20499 = *Luf-useep*,	(Malhetada).
11.	N. P. D. $65° \ 29'$	06529 = *Far-egate*,	(Bochista).
12.	R. A. $21^h \ 6^m.9$	21069 = *Maf-oblat*,	(Manifatura).
13.	N. P. D. $63° \ 56'$	06356 = *Fan-inary*,	(Blanquero).
14.	R. A. $21^h \ 23^m.4$	21234 = *Mal-elope*,	(Marooned).
15.	N. P. D. $62° \ 32'$	06232 = *Fal-ejekt*,	(Bisneto).
16.	Jan. 19 = 19; Brightness = 0.66,	00719 = *Baz-arose*,	(Enviscar).
17.	First observation, Dec. 18 = 353^d; Second observation, Dec. 22 = 4^d later; Third observation, Dec. 30 = 8^d later	35348 = *Tud-ifold.*	(Nagueres).

Column I gives the required message expressed by the present code. It is pure jargon, arranged on a systematic plan. The telegrapher and the receiver (over a telephone-wire especially) must pay attention throughout, and every word *must* contain eight letters, neither more nor less. Column II gives the same message expressed in the "Science-Observer Code." I submit that its jargon has all the disadvantages of Column I, and that it has others peculiar to its own fundamental system. The message as in Column I can be written with one opening of the book, and in a very much shorter time than that in Column II. In

practice, the form on the left of the page is first prepared; next, the prefixes are entered from Table I, and, lastly, the affixes from Table II.

SIX-WORD POSITION-MESSAGE.

All such messages, and only such, begin with the name of a month.

Following is a scheme of a six-word position-message, which is well adapted to send either an accurate or an approximate position.

Word No. 1.—Month of the date of the observation (in English; as *January*).

Word No. 2.—A number-word of eight letters, giving the Greenwich day and thousandths of a day. Thus, *Sik-orous* = 30989 = $30^d.989$ G. M. T. (day begins at noon).

Word No. 3.—A number-word of eight letters, which gives the hours, minutes, and the tens of seconds of time of the position in R. A. Thus, *Mitodate* = 22371 = $22^h\ 37^m\ 1\_^s$.

Word No. 4.—A number-word of eight letters, which gives the N. P. D. to the next less 1′; as *Kinarine* = 161° 20′.

Word No. 5.—A number-word of eight letters, which gives—*first*, the fourth decimal of the day (date); *second*, the units and the tenths of seconds of time (R. A.); *third*, the seconds of arc (N. P. D.). Thus, *Rif-eroon* = 27839, meaning $0^d.0002$ (to be added to the data of Word No. 2, making the date $30^d.9892$), and $7^s.8$ in R. A. (to be added to the data of Word No. 3, making the R. A. $22^h\ 37^m\ 17^s.8$), and 39″ in N. P. D. (to be added to the data of Word No. 4, making the N. P. D. 161° 20′ 39″).

Word No. 6.—A number-word of eight letters, used as a control, and representing one-fourth of the sum of words 2, 3, 4, and 5.

N. B.—To send an *approximate* position, proceed precisely as above, *except* that Word No. 5 must be replaced by the arbitrary cipher-word, *Nearness*, which shows the receiver that an approximate place is intended.

N. B.—See Table IV, No. 51121.

THIRTEEN-WORD MESSAGE.

ANNOUNCEMENT OF A DISCOVERY.

N. B.—Always fill up the full complement of words. The six-word message will find its application here.

Word No. 1.—Phrase-word (Table IV) of six letters and two syllables, naming the object discovered; as *bushel* = A comet was discovered by——at——on——.

Word No. 2.—Discoverer's name; if unknown, put *question*.

Word No. 3.—Discoverer's station; if unknown, put *unknown*.

Word No. 4.—Date of discovery; if unknown, put *nix*.

If the *day* of discovery (only) is known, Word No. 4 will be of three letters; as November 20, *local date* (common year) = 324^d = *Suf;* otherwise, of eight letters, giving the Greenwich day and hundredths of a day; as *Suf-egate* = $324^d.29$ G. M. T.

Words Nos. 5, 6, 7, 8, 9, 10.—Six-word position-message, exactly as above (words of eight letters from Tables I and II).

Word No. 11.—Daily motion in R. A. in seconds of time, which will always be given by a number-word of eight letters; as *Dilatrip* = 4025^s.

N. B.—If unknown, write *voidness*.

Word No. 12.—Daily motion in N. P. D. in *minutes* and tenths of minutes* (not degrees and minutes) of arc, which will always be given by a number-word of eight letters, as *Bak-imony* = 15.5′.

N. B.—If unknown, write *zerotion*.

Word No. 13.—Direction of motion in R. A. and N. P. D. Send one of the five words (from Table IV) following:

beetle = the daily motions are north and west.

beggar = the daily motions are north and east.

behave = the daily motions are south and west.

behest = the daily motions are south and east.

become = the daily motions are unknown both in amount and direction.

N. B.—Always fill up the full complement of thirteen words. They are sometimes unnecessary, it is true; they always cost slightly more than eight or ten; but if all the information can be sent it is important; and if any item of it is unknown that fact should be explicitly stated.

Example of Announcement of Discovery Message.

The message to be sent is: "A faint comet was discovered by Barnard at Nashville on October 14. Its position October 15 at $9^h\ 30^m\ 15^s$ is R. A. $2^h\ 27^m\ 13^s.5$, N. P. D. 27° 13′ 23″. Its daily motion in R. A. is (-72^s), and in N. P. D. (−8′).

Word 1 = Phrase-word, Table IV = *Butler* (No. 51082).

Word 2 = Discoverer's name = *Barnard*.

Word 3 = Discoverer's station = *Nashville*.

Word 4 = Date October 14 = 287^d (not leap year) = *Rol*.

Word 5 = October = *October*.

Word 6 = $15^d\ 9^h\ 30^m\ 15^s$ = 15.396 (0) = *Kan-upate*.

Word 7 = R. A. $2^h\ 27^m\ 1-^s$ = 02271 = *Boz-odate*.

Word 8 = N. P. D. 27° 13′ (23″) = 02713 = *Bun-alist*.

$$\text{Word 9}\left\{\begin{array}{lr} =\text{Fourth decimal of the day} & =0 \\ =\text{Seconds of R. A. } 3^s.5 & =035 \\ =\text{Seconds of N. P. D. } 23'' & =\underline{00023} \\ \text{Aggregate} & =03523 \end{array}\right\} = \textit{Dar-ation.}$$

Word 10.—Control-word = *Duz-ogoon*.

Formed thus:
```
15396
02271
02713
03523
-----
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Sum, 23903; ¼ sum = 05976.

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* The tenths, not necessary here, are used so as to be consistent with Table IV, No. 51029, where they are necessary.

Word 11.—Daily motion in R. A. = —72ˢ = *Baf-ofant.*
Word 12.—Daily motion in N. P. D. = —08′.0 = *Baf-olute.*
Word 13.—The motion is north and west = *beetle.*

REMARK.

The control-words in the various messages can be employed to correct errors of transmission as well as to detect their existence.

SHORT INDEX TO TABLE IV.

Phrases, TABLE IV. Arbitrary Cipher-Code.

It is sometimes convenient, and it always saves expense, to have a phrase-code in which arbitrary words in the telegram stand for whole sentences in the translation.

In my opinion, such tables are generally too long.

The following table is essentially a copy of the "Science-Observer Code" sentences (and precepts), with different cipher-words, however. Every cipher-word belonging in this table has two syllables and six letters; no more, no less. I have added a few needed phrases.

Each word in Table IV is numbered, as *babble* = 51000. By previous agreement between two correspondents the cipher-words (second column), may be used to transmit the numbers in the first column. The blank spaces in the third column can be filled in, by agreement, as new wants arise.

No.	Cipher-Word.	Corresponding Phrase.
51000	babble =	*The exact Greenwich mean time* (day begins at noon) *is* or *was*——— N. B.—The time is to be expressed in days and decimals of a day. *Example:* Babble Roneglet = the G. M. T. is $288^d.30$ = Oct. $15^d\ 7^h\ 12^m$. Babble Roneglet Bodakute = Oct. $15^d\ 7^h\ 12^m\ 12^s.2$ ($+0^d.0001412$).
51001	baboon =	*The object is in the Bonn DM.* (between +90° and +0° Decl.).
51002	badger =	*The object is in the Bonn DM.* (between 0° and — 23° Decl.).
51003	ballad =	
51004	ballot =	*The object is in the C. G. H.* (*photographic*) *DM.*
51005	bandit =	*The object is in the Cordoba* (*visual*) *DM.*
51006	banyan =	N. B.—The Cipher-words for DM. stars will be followed by two number-words. *First.*—The *prefix* to the first word gives the Decl. of the zone. (See the top of the page in the DM.). *Second.*—The *affix* to the first word gives the magnitude of the star, in tenths of a magnitude, where 9.9 is assumed to be the magnitude of every star fainter than 9.8. *Third.*—The second word gives the star's number in its zone. Thus, if there were a Bonn DM. star of 9.6 mag. —13° Decl., No. 4417 in that zone, we could denote it by *badger, bitupate* *dodamope.* 13, 96 4417
51007	banker =	*The object is on the photographic plates taken at the Observatory of*——— N. B.—The cipher-word is followed by the name of the observatory; as Harvard, Paris, Naples.

No.	Cipher-Word.	Corresponding Phrase.
51008	barber=	*The object is not on the negatives taken at*———
51009	barley=	*The object is in Dreyer's New General Catalogue of Nebulæ*, No.——(if followed by a number-word).
51010	barrel=	*The object is in Dreyer's Index-Catalogue of Nebulæ*, 1888–94, No.——(if followed by a number-word). N. B —The cipher-word may be followed by a number-word of eight letters, which gives the number of the object in the catalogue referred to.
51011	barrow=	
51012	barter=	The object follows the (star) next named by——— seconds of time (prefix).
51013	basely=	The object precedes the (star) next named by——— seconds of time (prefix).
51014	bashaw=	The object is north of the (star) next named by——— minutes of arc (affix).
51015	basket=	The object is south of the (star) next named by——— minutes of arc (affix). N. B —Two of the cipher-words will be followed by a number-word whose *prefix* gives Δ R. A., and whose *affix* gives $\Delta\ \delta$. N. B.—Name the comparison star afterwards. For exact positions, see page 114.
51016	bathos=	*and is north-preceding (the object next named in the message).*
51017	battle=	*and is north-following (the object next named in the message).*
51018	bawble=	*and is south-following (the object next named in the message).*
51019	beacon=	*and is south-preceding (the object next named in the message).*
51020	beater=	*the position with reference to*———
51021	beauty=	*the position angle is*——(number-word; *deg. and min.*).
51022	beaver=	*the distance is*——(number-word; *seconds of arc*).
51023	become=	The daily motions are unknown both in amount and direction.
51024	beetle=	*The daily motion of the comet (or object) is towards north and west.*
51025	beggar=	*The daily motion of the comet (or object) is towards north and east.*
51026	behave=	*The daily motion of the comet (or object) is towards south and west.*
51027	behest=	*The daily motion of the comet (or object) is towards south and east.*
51028	behold=	*The amount of the daily motion in R. A. is (in seconds of time).* N. B.—The cipher-word is to be followed by a number-word, always of eight letters, which expresses the daily motion in seconds of time. This will always be less than 5099^s.
51029	behoof=	*The amount of the daily motion in N. P. D. is (in minutes and tenths of minutes of arc).* N. B.—The cipher-word is to be followed by a number-word, always of eight letters, which expresses the daily motion in N. P. D in minutes and tenths of minutes of arc. This will be less than $5099'.9$.

No.	Cipher-Word.	(See 51071). Corresponding Phrase. (See 51122).
51030	beldam =	
51031	belfry =	
51032	bellow =	
51033	belong =	*The* elements *of Comet a are* (See 51068).
51034	bemoan =	*The elements of Comet b are*
51035	benign =	*The elements of Comet c are*
51036	bestir =	*The elements of Comet d are*
51037	betake =	*The elements of Comet e are*
51038	betray =	*The elements of Comet f are*
51039	better =	*The elements of Comet g are*
51040	bewail =	
51041	beware =	
51042	beyond =	*The* ephemeris *of Comet a follows.*
51043	bicker =	*The ephemeris of Comet b follows.*
51044	biffin =	*The ephemeris of Comet c follows.*
51045	billet =	*The ephemeris of Comet d follows.*
51046	billow =	*The ephemeris of Comet e follows.*
51047	binder =	*The ephemeris of Comet f follows.*
51048	bisect =	*The ephemeris of Comet g follows.*
51049	bitter =	
51050	blazon =	
51051	bobbin =	*The* elements and ephemeris *of Comet a follow.*
51052	bodice =	*The elements and ephemeris of Comet b follow.*
51053	bodkin =	*The elements and ephemeris of Comet c follow.*
51054	bolter =	*The elements and ephemeris of Comet d follow.*
51055	bonnet =	*The elements and ephemeris of Comet e follow.*
51056	border =	*The elements and ephemeris of Comet f follow.*
51057	borrow =	*The elements and ephemeris of Comet g follow.*
51058	bother =	
51059	bottle =	
51060	bounty =	*An* ephemeris *of three positions at four-day intervals.*
51061	boxing =	*An ephemeris of four positions at four-day intervals.*
51062	boyish =	*An ephemeris of six positions at four-day intervals.*

No.	Cipher-Word.	Corresponding Phrase.
51063	brandy =	*An* ephemeris *of eight positions at four-day intervals.*
51064	brassy =	*An ephemeris of three positions at eight-day intervals.*
51065	brawny =	*An ephemeris of four positions at eight-day intervals.*
51066	breezy =	*An ephemeris of six positions at eight-day intervals.*
51067	brewer =	*An ephemeris of eight positions at eight-day intervals.*
51068	briber =	*Compare the elements sent you with those of the——— Comet of———.* (See Publ. A. S. P., No. 50).

N. B.—The cipher-word is followed by a number-word of eight letters.

First.—Write out the number corresponding.

Second.—Cut off the last figure, which gives the number of the comet in the year.

Third.—The first four figures give the year A. D.

51069	bridal =	
51070	broken =	*The* auxiliary constants *for the equator to be used in computing an ephemeris are as follows:*

N. B.—The cipher-word will always be followed by seven number-words of eight letters, the first six representing a b c, A, B, C, in the equations.

$$x = r \sin a \sin (A+v)$$
$$y = r \sin b \sin (B+v)$$
$$z = r \sin c \sin (C+v)$$

The angles are expressed in degrees (corresponding to the prefix) and minutes (the figures of the affix always represent the minutes).

The seventh number-word is a control-word, and represents one-fourth of the sum of the preceding six words.

Example: $a = 81° 21'$, $b = 76° 23'$, $c = 16° 20'$, $A = 170° 41'$, $B = 262° 17'$, $C = 49° 11'$ would be represented by

broken
1. *Foyaship* = 081 21
2. *Fokation* = 076 23
3. *Bokarine* = 016 20
4. *Koreting* = 170 41
5. *Pozamope* = 262 17
6. *Dopahold* = 049 11

One-quarter of (655 33) = 163 83 = *Kitomous*, which is the control-word.

51071	brutal =	*These are* elliptic elements *which follow:*

N. B.—The cipher-word will be followed by two number-words of eight letters. The first gives the eccentricity (e) to the nearest fourth decimal place; the second gives the periodic time expressed in years and hundredths of a year.

51072	bubble =	*The deviation (C—O) of the middle place when + in* λ *and + in* β *is*
51073	bucket =	*The deviation (C—O) of the middle place when + in* λ *and — in* β *is*
51074	budget =	*The deviation (C—O) of the middle place when — in* λ *and + in* β *is*
51075	buffer =	*The deviation (C—O) of the middle place when — in* λ *and — in* β *is*

N. B.—The cipher-words will be followed by a number-word of eight letters, the first three figures of which give $\Delta\lambda \cos \beta$, and the last two figures of which give $\Delta\beta$, both expressed in minutes and tenths of arc.

	$\Delta\lambda \cos \beta$	$\Delta\beta$
Example:	(C—O) = —18'.8	—0'.6 is expressed by
	buffer	*Lifadore*
		188 06

No.	Cipher-Word.	Corresponding Phrase.
51076	bullet= 1. Add to *bullet* the word *bubble* for ΔR.A.+, ΔN.P.D.+; (C—O). 2. *bucket* for ΔR.A.+, ΔN.P.D — 3. *budget* for ΔR.A.—, ΔN.P.D.+ 4. *buffer* for ΔR.A.—, ΔN.P.D.—	*The position of the observed place with reference to the predicted place (C—O) is, approximately,* N. B.—The cipher-word will be followed by a cipher-word (see adjacent column) and by one number-word of eight letters. The affix gives (C—O) in R. A. expressed in seconds of time. The prefix gives (C—O) in *north polar distance* expressed in minutes and tenths of minutes of arc.
51077	bunker=	*The (C—O) is not known.*
51078	burden=	*The* physical appearance *of the object is as follows:* N. B.—The cipher-word will be followed by English words describing the appearance as "bright," 'circular," "large," etc., as desirable.
51079	bushel=	*A* comet *was discovered by———, at———, on———.*
51080	buskin=	A *bright comet was discovered by ———, at———, on———.*
51081	bustle=	*A very bright comet was discovered by———, at———, on———.*
51082	butter=	*A faint comet was discovered by ———, at———, on———.*
51083	byword=	*A very faint comet was discovered by———, at———, on———.*
51084	dagger=	*A* planet *was discovered by———, at———, on———.*
51085	damage=	*A planet fainter than 13 mag. was discovered by———, at———, on ———.* N. B.—The cipher-word will be followed by three words giving 1°) name of discoverer 2°) his station 3°) a date-word of three letters from Table I (the day is expressed in local mean time (day begins at noon).
51086	damask=	*A comet was found on the negatives of———.*
51087	damsel=	*A planet was found on the negatives of———.*
51088	danger=	
51089	dapple=	*The periodic comet of———has been observed by———, at———, on ———.* N. B.—The cipher-word is followed by four words giving 1°) name of comet 2°) observer 3°) his station 4°) date-word of three letters (the day is expressed in the local mean time of the observer).
51090	dawdle=	*Possibly a comet.*
51091	dazzle=	*Probably a comet.*

No.	Cipher-Word.	(See pp. 128-9). Corresponding Phrase.
51092	deacon=	*Not a comet.*
51093	dealer=	*Possibly a planet.*
51094	debase=	*Probably a planet.*
51095	debate=	*Possibly a nebula.*
51096	decree=	*Probably a nebula.*
51097	deface=	*The comet was looked for, but not found.* (See 51223).
51098	defect=	*The planet was looked for, but not found.* (See 51223).
51099	defend=	*Please observe* markings *on*——(Mercury, Venus, etc.)——.
51100	defile=	*A marking on the planet——is central at——(Greenwich date).*
51101	deject=	*Please observe* (photograph) changes in the tail of Comet——.
51102	deluge=	*Please observe changes in the head of Comet——(now in progress).*
51103	dental=	*Bright projection on* Mars' *terminator at (Greenwich date).*
51104	depend=	
51105	depict=	*Please send* by mail *an observation of as early a date in the year as you can.*
51106	deploy=	*Please send by mail an observation of as late a date in the year as you can.*
51107	depose=	*Please send by mail any observation.*
51108	depute=	*Please send by mail two observations.*
51109	deride=	*Please send by mail three observations.*
51110	desert=	*Please send by mail elements and ephemeris.*
51111	design=	*Please* telegraph *an observation of as early a date in the year as you can.*
51112	desist=	*Please telegraph an observation of as late a date in the year as you can.*
51113	despot=	*Please telegraph any observation.*
51114	detail=	*Please telegraph two observations.*
51115	detect=	*Please telegraph three observations.*
51116	detest=	*Please telegraph any data you can.*
51117	device=	*Please telegraph elements.*
51118	devoid=	*Please telegraph ephemeris.*
51119	devour=	*Please telegraph elements and ephemeris.*
51120	differ=	*Was discovered by—— (at——, on——).*
51121	digest=	*Was observed by—— (at——, on——).*
51122	dilate=	*Was computed by—— (at——, on——).*

No.	Cipher-Word.	Corresponding Phrase.
51123	dimple =	*A* variable *star was found on the negatives of*———.
51124	dipper =	*A* new *star was found on the negatives of*———.
51125	direct =	*The variability of the star (object) was discovered by* ——— (*at*———, *on*———).
51126	disarm =	*A new star was discovered by* ——— (*at*———, *on* ———). See No. 51144. See Nos. 51147–8.
		N. B.—The two cipher-words just preceding will be followed by three words 1°) the discoverer's name 2°) his station 3°) a date-word of three letters from Table I (the day should be expressed in local mean time of observer).
51127	dismal =	*Possibly this object is variable.*
51128	distil =	*Probably this object is variable.*
51129	divert =	*The epoch of maximum and period are*———
51130	divine =	*The epoch of minimum and period are*———
		N. B.—The two foregoing cipher-words will be followed 1°) by a number-word, which will give the epoch in Greenwich days and hundredths of a day, and 2°) by a number-word, which will give the period in days and hundredths of a day.
51131	docile =	*A minimum occurred on*———
51132	doctor =	*A minimum will occur on*———
51133	dollar =	*A maximum occurred on*———
51134	domain =	*A maximum will occur on*———
		N. B.—These cipher-words will be followed by 1°) a date-word of three letters giving the local mean day, or 2°) by a number-word of eight letters giving the day and hundredth of a day (G. M. T.).
51135	dotage =	*The epoch and period are not known.*
51136	dragon =	*The period is short.*
51137	dreamy =	*The period is long.*
51138	dressy =	*The variable is of the Algol type.*
51139	drivel =	*The variable is of the Eta Aquilæ type.*
51140	drover =	*A shower of* meteors *is now in progress.*
51141	duster =	*A shower of meteors will probably occur* (Greenwich date).
51142	fabric =	*The radiant is* or *was*———.
		N. B.—The cipher-word will be followed by two number-words, giving 1°) R. A. in hours, minutes, and tenths of minutes; 2°) N. P. D. in degrees and minutes.

No.	Cipher-Word.	Corresponding Phrase.
51143	facile=	*The* variation *in magnitude is*———. N. B.—The cipher-word will be followed by a number-word of eight letters 1°) the first three places give the max. brightness in mags. and tenths 2°) the last two places (mags. and tenths) added to the max. brightness give the minimum brightness in mags. and tenths). *Example:* The variability of BD+1°, 3408 was discovered by Sawyer, at Cambridge, February 17 (local date). The epoch of minimum is July 17, $15^h 45^m$ G. M. T., and the period is $0^d 20^h$. The variation of mag. is from 6.0 to 6.8. The variable is of the *Algol* type. These facts are expressed as follows: *Direct* The variability of the star was disc. by—. *Sawyer* [at] (*Cambridge*) [on] *Don* [The date of discovery is Feb. 17=48^d.] *baboon* [The star is in the B. D., north of 0°.] *Bakiptik* [Decl. + 1°, mag. 6.0.] *Dapafras* [The number in the zone 3408.] *Divine* [The epoch of minimum is—.] *Lonitous* [July 17, $15^h 45^m = 198^d.65$.] *Bafomous* [The period is $0^d.83$] *Facile* [The variation in brightness is—.] *Fafafras* [The max. brightness is 6.0, the min. 6.8.] *Dressy* [The variable is of the *Algol type*.] N. B.—Be careful to give similar messages in this precise order.
51144	factor=	*Has suddenly appeared.*
51145	falcon=	*Will appear in the Northern Hemisphere.*
51146	fallow=	*Will appear in the Southern Hemisphere.*
51147	famish=	*The* magnitude *is as follows* (*when brighter than 10.0 mag.*).
51148	father=	*The magnitude is as follows* (*when fainter than 10.0 mag.*). N. B.—The cipher-words will be followed by a number-word, or by several number-words each of eight letters. Each number-word is to be written out in figures. The first three figures represent the day of the year (G. M. T.). The last two figures give the mag. directly (when the star is brighter than 10), or they give the (mag.—10.0) in case the cipher-word is "father."
51149	fathom=	*There is a large, or remarkable, spot on the sun.*
51150	fatten=	*There is a remarkable protuberance on the sun.* (See No. 51021).
51151	faulty=	*There seems to be an inter-mercurial planet on the sun.*
51152	feeble=	*There seems to be a comet on the sun.*
51153	feline=	*A bright comet is near the sun.* (See 51012, etc.).
51154	fencer=	*Please observe a probable* occultation *by Comet*—— (G. M. T.).
51155	fender=	*The planet next named will occult a star on* (Greenwich date).
51156	ferret=	*Please observe an occultation on*——— (Greenwich date).
51157	fetter=	*Changes in the Moon's surface are reported by*——. (See 51158–61).

CIPHER-WORD.	CORRESPONDING PHRASE.
fickle =	*The object is on Schmidt's lunar map in* $+\lambda$ *and* $+\beta$,
fidget =	*The object is on Schmidt's lunar map in* $+\lambda$ *and* $-\beta$,
fillet =	*The object is on Schmidt's lunar map in* $-\lambda$ *and* $+\beta$,
finder =	*The object is on Schmidt's lunar map in* $-\lambda$ *and* $-\beta$. N. B.—If cipher-words 51158–51161 are followed by a number-word, the *prefix* gives λ, the *affix* β, expressed in degrees.
finger =	*The* spectrum *is continuous.*
finite =	*The spectrum is normal.*
fisher =	*The spectrum is monochromatic.*
flagon =	*The spectrum is peculiar.*
flashy =	*The spectrum is like that of a comet.*
flaxen =	*The spectrum is like that of a nebula.*
flinty =	*The stellar spectrum is type* I (Secchi),
floral =	*The stellar spectrum is type* II (Secchi),
flower =	*The stellar spectrum is type* III (Secchi),
fluent =	*The stellar spectrum is type* IV (Secchi).
flurry =	*The stellar spectrum is type* (Wolf-Rayet).
foment =	*The hydrogen lines are bright.*
forage =	*The hydrogen lines and* D_3 *arc bright.*
forger =	*The spectrum contains bright lines or bands.*
formal =	*The spectrum contains dark lines or bands.*
fossil =	*Please observe the following line(s)*———. N. B.—Each number-word (of eight letters), following these cipher-words gives the wave length of a single line (or band), in millionths of a millimeter.
freely =	*The spectrum has been* photographed *at*———.
frenzy =	*The object has been photographed at*———.
frigid =	*The region has been photographed at*———.
frolic =	*The object has been photographed here.*
frosty =	*The spectrum has been photographed here.*
frugal =	*The region has been photographed here.*
fuller =	*The* color *of the object is white.*
funnel =	*The color of the object is very blue.*
furrow =	*The color of the object is blue.*

No.	Cipher-Word.	Corresponding Phrase.
51187	fusion=	*The color of the object is yellow.*
51188	halter=	*The color of the object is red.*
51189	hammer=	*The color of the object is very red.*
		Miscellaneous.
51190	harbor=	*The* magnitude *is not known.*
51191	harrow=	*The magnitude is brighter than*———
51192	hatred=	*The magnitude is fainter than*———
51193	hazard=	*The magnitude is equal to*———. (See 51147–8)
51194	heaven=	*The variation is large.*
51195	hector=	*The variation is small.*
51196	helmet=	*The* brightness *is increasing.*
51197	herald=	*The brightness is decreasing.*
51198	hermit=	*The brightness is increasing rapidly.*
51199	hollow=	*The brightness is decreasing rapidly.*
51200	homely=	*The brightness has increased rapidly.*
51201	honest=	*The brightness has decreased rapidly.*
51202	humane=	*It is* visible *to the naked eye.*
51203	hunger=	*It will become visible to the naked eye.*
51204	hussar=	*It will become very brilliant.*
51205	keeper=	*A suspicious object.*
51206	kennel=	*Greater than.*
51207	kidnap=	*Less than.*
51208	kingly=	*The earliest* observation *known is.*
51209	lackey=	*The latest observation known is.*
51210	lagoon=	*At several observatories.*
51211	lament=	*By several astronomers.*
51212	lancet=	*On several nights.*
51213	larder=	*The following observatories.*
51214	latent=	*The following observations.*
51215	lavish=	*Corrections for parallax and aberration have applied.*
51216	leader=	*Corrections for parallax and aberration have been applied.*
51217	leaven=	*is a rough approximation.*

No.	Cipher-Word.	Corresponding Phrase.
51218	ledger =	*is still uncertain.*
51219	legate =	*is quite accurate.*
51220	lentil =	*The* position *is*———
51221	levant =	*The position used is*———
51222	levite =	*The position is not known.*
51223	lictor =	*The* object *was looked for, but not found.* (See 51097).
51224	limber =	*The object has been seen.*
51225	linden =	*The object has not been seen.*
51226	lining =	*The object has not been seen here since discovery.*
51227	linnet =	*The object has not been seen by any one else.*
51228	lizard =	*The object was not observed till*———
51229	loafer =	*The object has not been observed since*———
51230	locker =	*The object cannot be observed until*———
51231	locust =	*The object cannot be observed after*———
		WEATHER; LONGITUDE CAMPAIGN.
51232	lodger =	*On account of moonlight, or twilight.*
51233	lordly =	*On account of clouds.*
51234	lubber =	*On account of moonlight, twilight or clouds.*
51235	lumber =	*It is cloudy here.*
51236	madman =	*It has been cloudy here.*
51237	magnet =	*It probably will be cloudy here.*
51238	magpie =	*Is it cloudy at your station ?*
51239	maiden =	*Signals will be sent to-night at*———G. M. T.
51240	malice =	*Signals will be sent to-morrow at*———G. M. T.
51241	manful =	*Repeat exchange of signals to-night at*———G. M. T.
51242	mangle =	*No more signals to-night.*
51243	marble =	*Was exchange of signals satisfactory? Answer immediately.*
51244	marine =	*How many more nights' work needed at this station?*
51245	market =	*Your signals are not satisfactory.*
51246	marmot =	*My clock-corrcction is well determined.*
51247	marrow =	*My clock-correction is* not *well determined.*

No.	Cipher-Word	Corresponding Phrase.
		Correspondence. (See page 122).
51248	martin =	*Our letter.*
51249	marvel =	*Our telegram.*
51250	master =	*Your letter.*
51251	matron =	*Your telegram.*
51252	meddle =	*Your letter has been received.*
51253	medium =	*Your telegram has been received.*
51254	menace =	*Answer by letter.*
51255	mental =	*Answer by telegraph.*
51256	method =	*We have written.*
51257	midway =	*We will write.*
51258	mildew =	*We have telegraphed.*
51259	miller =	*We will telegraph.*
51260	mingle =	*We are sure.*
51261	mirror =	*We are not sure.*
51262	mishap =	*Is right.*
51263	missal =	*Is not right.*
51264	mister =	*Was found to be.*
51265	modest =	*Is supposed to be.*
51266	morbid =	*Is not supposed to be.*
51267	mortal =	*Please repeat your last telegram.*
51268	mother =	*There was an* error *in my telegram.*
51269	motley =	*There was an error in my letter.*
51270	muddle =	*Instead of———, read———* N. B.—The cipher-word is to be followed by two words;
51271		first gives the erroneous datum; the second the correct one.
51272	murder =	*Will be sent:*
51273	muslin =	*Cannot be sent.*
51274	mutton =	*Cannot be sent by telegraph* (see my letter).
51275	mystic =	*Do you want positions?*
51276	[nix] =	We do not know the date of discovery—used in thirteen-word message. See *ante.*
51277	oblong =	*We have one position.*
51278	obtain =	*We have two positions.*

No.	Cipher-Word.	Corresponding Phrase.
51279	offend =	*We have three positions.*
51280	office =	*We will look for the object.*
51281	offset =	*Please look for the object.*
51282	onward =	*The announcement of the discovery of a comet (or planet) by——has been received here.* N. B.—The discoverer's name follows the cipher-word.
51283	oppose =	*Please forward the information by telegraph to——*
51284	orphan =	*Please do not forward the information to——*
51285	outcry =	*Please distribute this information by telegraph.*
51286	outfit =	*Please do not distribute this information by telegraph.*
51287	outset =	*It is for your private information only.*
51288	packet =	*Please verify before distributing.*
51289	palace =	*The foregoing appears to be somewhat doubtful.*
51290	pallid =	*For further information apply direct to——.*
51291	parade =	Please observe the object visually.
51292	parcel =	Please observe the object photographically.
51293	parent =	Please observe the object spectroscopically.
51294	parish =	*Aurora Borealis.*
51295	parrot =	*Zodiacal Light.*
		CONTROL-WORDS.
51296	parson =	The sum of the numbers corresponding to all the number-words of eight letters (excluding words of three letters), in this message, up to and excluding the control- $\left\{\begin{matrix}\text{word}\\\text{or words}\end{matrix}\right\}$ following is——
51297	pastor =	The following control-word is ½ of the sum of the two number-words of eight letters preceding it.
51298	patent =	The following control-word is ⅓ of the sum of the three number-words of eight letters preceding it.
51299	patrol =	The following control-word is ¼ of the sum of the four number-words of eight letters immediately preceding it.
51300	pebble =	The following control-word is ⅕ of the sum of the five number-words of eight letters immediately preceding it.
51301	pedant =	The following control-word is $\frac{1}{n}$ of the sum of the *n* number-words of eight letters immediately preceding it (*i. e.*, of all such).

TABLE I (PREFIXES).

The table gives *numbers* (with Table II); *local mean dates* (if used alone; see Table III).
N. B.—Write three figures to correspond with each prefix. *Example:* *Fil*=070, not 70.

Vowels.	B	D	F	H	J	K	L	M	P	R	S	T	V	Vowels.	W	Y	Z	N
af	000	030	060	090	120	150	180	210	240	270	300	330	360	*af*	390	420	450	480
ak	001	031	061	091	121	151	181	211	241	271	301	331	361	*ak*	391	421	451	481
al	002	032	062	092	122	152	182	212	242	272	302	332	362	*al*	392	422	452	482
an	003	033	063	093	123	153	183	213	243	273	303	333	363	*an*	393	423	453	483
ap	004	034	064	094	124	154	184	214	244	274	304	334	364	*ap*	394	424	454	484
ar	005	035	065	095	125	155	185	215	245	275	305	335	365	*ar*	395	425	455	485
at	006	036	066	096	126	156	186	216	246	276	306	336	366	*at*	396	426	456	486
az	007	037	067	097	127	157	187	217	247	277	307	337	367	*az*	397	427	457	487
if	008	038	068	098	128	158	188	218	248	278	308	338	368	*if*	398	428	458	488
ik	009	039	069	099	129	159	189	219	249	279	309	339	369	*ik*	399	429	459	489
il	010	040	070	100	130	160	190	220	250	280	310	340	370	*il*	400	430	460	490
in	011	041	071	101	131	161	191	221	251	281	311	341	371	*in*	401	431	461	491
ip	012	042	072	102	132	162	192	222	252	282	312	342	372	*ip*	402	432	462	492
it	013	043	073	103	133	163	193	223	253	283	313	343	373	*it*	403	433	463	493
od	014	044	074	104	134	164	194	224	254	284	314	344	374	*od*	404	434	464	494
of	015	045	075	105	135	165	195	225	255	285	315	345	375	*of*	405	435	465	495
ok	016	046	076	106	136	166	196	226	256	286	316	346	376	*ok*	406	436	466	496
ol	017	047	077	107	137	167	197	227	257	287	317	347	377	*ol*	407	437	467	497
on	018	048	078	108	138	168	198	228	258	288	318	348	378	*on*	408	438	468	498
op	019	049	079	109	139	169	199	229	259	289	319	349	379	*op*	409	439	469	499
or	020	050	080	110	140	170	200	230	260	290	320	350	380	*or*	410	440	470	500
oy	021	051	081	111	141	171	201	231	261	291	321	351	381	*oy*	411	441	471	501
oz	022	052	082	112	142	172	202	232	262	292	322	352	382	*oz*	412	442	472	502
ud	023	053	083	113	143	173	203	233	263	293	323	353	383	*ud*	413	443	473	503
uf	024	054	084	114	144	174	204	234	264	294	324	354	384	*uf*	414	444	474	504
ug	025	055	085	115	145	175	205	235	265	295	325	355	385	*ug*	415	445	475	505
ul	026	056	086	116	146	176	206	236	266	296	326	356	386	*ul*	416	446	476	506
un	027	057	087	117	147	177	207	237	267	297	327	357	387	*un*	417	447	477	507
up	028	058	088	118	148	178	208	238	268	298	328	358	388	*up*	418	448	478	508
uz	029	059	089	119	149	179	209	239	269	299	329	359	389	*uz*	419	449	479	509

EXPLANATION OF TABLES I, II, III.

Precepts: Table I. Read the initial at the top of the column with a combination from the column "Vowels"; as *Hok* = 106, *Noy* = 501.

I. All *numbers* are expressed by words of eight letters (invariably). Such words are made up of a *prefix* from Table I with an *affix* from Table II. Thus, 10647 = *Hokience;* 01065 = *Bililous.* Numbers larger than 50999 must be divided into two parts, A and B, and telegraphed as A+B. Thus, 80711 = 40000+40711, which is telegraphed as *Wilnicht* plus *Wolahold*, and so on. When angles are in question, the degrees (only) are given by Table I, and the minutes by Table II; as 357° 29′ = *Tunegale;* 0° 15′ = *Bafalone.*

II. All *dates*, to the nearest day only, are expressed as *local mean dates* invariably in words of three letters (prefixes) taken from Table I, and interpreted by Table III. *Example: Hok* (standing alone) = 106d = April 16 (local mean date); November 29 = 333d = *Tan.*

III. To express the *Greenwich date* to the nearest hundredth of a day, use a number-word of eight letters from Tables I and II. Thus, February 29.67 = 60d.67 = *Fafitude; Todilade* = 344d.50 = December 10.50 (if the year is not a leap-year). A second number-word will give the seventh decimal of the day, if desired.

All ambiguity is avoided if the above precepts are obeyed, together with a few special precepts given in what precedes.

Numbers. TABLE II (AFFIXES).

These are always used with prefixes from Table I. N. B.—Write two figures to correspond with each affix. *Example:* Adieu is 04.

00	*-nicht*	20	*-arine*	40	*-estry*	60	*-iplik*	80	*-olute*
01	-aband	21	-aship	41	-eting	61	-irekt	81	-omane
02	-abate	22	-aside	42	-event	62	-irize	82	-omist
03	-about	23	-ation	43	-ibale	63	-iside	83	-omous
04	-adieu	24	-ative	44	-ibode	64	-itark	84	-oniks
05	-adize	25	-atrip	45	-ibrew	65	-itous	85	-opsis
06	-adore	26	-avish	46	-ident	66	-iture	86	-orate
07	-aflow	27	-eblow	47	-ience	67	-itude	87	-ordik
08	-afras	28	-educe	48	-ifold	68	-ivate	88	-ormus
09	-agile	29	-egate	49	-ijest	69	-oblat	89	-orous
10	*-aglow*	**30**	*-eglet*	**50**	*-ilade*	**70**	*-ocean*	**90**	*-ostik*
11	-ahold	31	-egraf	51	-ilant	71	-odate	91	-ugale
12	-akute	32	-ejekt	52	-ilege	72	-ofant	92	-ulate
13	-alist	33	-elekt	53	-imate	73	-often	93	-ulent
14	-alive	34	-elope	54	-iment	74	-ogism	94	-ulous
15	-alone	35	-embue	55	-imony	75	-ogive	95	-umate
16	-ament	36	-endow	56	-inary	76	-ogoon	96	-upate
17	-amope	37	-erade	57	-iness	77	-olist	97	-urant
18	-annex	38	-erkin	58	-inize	78	-olize	98	-urile
19	-arose	39	-eroon	59	-inode	79	-olode	99	-useep

Precepts: To express *numbers*, use Tables I and II; as *Manifold* = 21348. To express *angles*, *Manifold* = 213° 48′.

Dates. TABLE III. Day of the Year corresponding to each Month and Day (Common Years).

Day of Month.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day of Month.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day of Month
1	1	32	60	91	121	152	**1**	182	213	244	274	305	335	**1**
2	2	33	61	92	122	153	**2**	183	214	245	275	306	336	**2**
3	3	34	62	93	123	154	**3**	184	215	246	276	307	337	**3**
4	4	35	63	94	124	155	**4**	185	216	247	277	308	338	**4**
5	5	36	64	95	125	156	**5**	186	217	248	278	309	339	**5**
6	6	37	65	96	126	157	**6**	187	218	249	279	310	340	**6**
7	7	38	66	97	127	158	**7**	188	219	250	280	311	341	**7**
8	8	39	67	98	128	159	**8**	189	220	251	281	312	342	**8**
9	9	40	68	99	129	160	**9**	190	221	252	282	313	343	**9**
10	10	41	69	100	130	161	**10**	191	222	253	283	314	344	**10**
11	11	42	70	101	131	162	**11**	192	223	254	284	315	345	**11**
12	12	43	71	102	132	163	**12**	193	224	255	285	316	346	**12**
13	13	44	72	103	133	164	**13**	194	225	256	286	317	347	**13**
14	14	45	73	104	134	165	**14**	195	226	257	287	318	348	**14**
15	15	46	74	105	135	166	**15**	196	227	258	288	319	349	**15**
16	16	47	75	106	136	167	**16**	197	228	259	289	320	350	**16**
17	17	48	76	107	137	168	**17**	198	229	260	290	321	351	**17**
18	18	49	77	108	138	169	**18**	199	230	261	291	322	352	**18**
19	19	50	78	109	139	170	**19**	200	231	262	292	323	353	**19**
20	20	51	79	110	140	171	**20**	201	232	263	293	324	354	**20**
21	21	52	80	111	141	172	**21**	202	233	264	294	325	355	**21**
22	22	53	81	112	142	173	**22**	203	234	265	295	326	356	**22**
23	23	54	82	113	143	174	**23**	204	235	266	296	327	357	**23**
24	24	55	83	114	144	175	**24**	205	236	267	297	328	358	**24**
25	25	56	84	115	145	176	**25**	206	237	268	298	329	359	**25**
26	26	57	85	116	146	177	**26**	207	238	269	299	330	360	**26**
27	27	58	86	117	147	178	**27**	208	239	270	300	331	361	**27**
28	28	59	87	118	148	179	**28**	209	240	271	301	332	362	**28**
29	29	..	88	119	149	180	**29**	210	241	272	302	333	363	**29**
30	30	..	89	120	150	181	**30**	211	242	273	303	334	364	**30**
31	31	..	90	...	151	...	**31**	212	243	...	304	...	365	**31**

Precepts: In leap-years, add one day after February 28. This table is to be used in connection with Table I to obtain the *local mean date* to the nearest day. Thus, August 10 = 222 days = *Mip.*

It is to be used in connection with both Tables I and II to obtain the Greenwich date to the hundredth of a day. Thus, August 10.16 = $222^d.16$ = *Mipament.*

TABLE V. To change Decimals of a Day to H. M. S.

A. Hundredths of the Day.

D	h	m	s	D	h	m	s	D	h	m	s
0,01	0	14	24	0,34	8	9	36	0,67	16	4	48
0,02	0	28	48	0,35	8	24	0	0,68	16	19	12
0,03	0	43	12	0,36	8	38	24	0.69	16	33	36
0 04	0	57	36	0,37	8	52	48	0,70	16	48	0
0,05	1	12	0	0,38	9	7	12	0,71	17	2	24
0,06	1	26	24	0,39	9	21	36	0,72	17	16	48
0,07	1	40	48	0,40	9	36	0	0,73	17	31	12
0,08	1	55	12	0,41	9	50	24	0,74	17	45	36
0,09	2	9	36	0.42	10	4	48	0,75	18	0	0
0,10	2	24	0	0,43	10	19	12	0,76	18	14	24
0,11	2	38	24	0,44	10	33	36	0,77	18	28	48
0,12	2	52	48	0,45	10	48	0	0,78	18	43	12
0,13	3	7	12	0,46	11	2	24	0,79	18	57	36
0,14	3	21	36	0,47	11	16	48	0,80	19	12	0
0,15	3	36	0	0,48	11	31	12	0,81	19	26	24
0,16	3	50	24	0,49	11	45	36	0,82	19	40	48
0,17	4	4	48	0,50	12	0	0	0,83	19	55	12
0,18	4	19	12	0,51	12	14	24	0,84	20	9	36
0,19	4	33	36	0,52	12	28	48	0,85	20	24	0
0,20	4	48	0	0,53	12	43	12	0,86	20	38	24
0,21	5	2	24	0,54	12	57	36	0,87	20	52	48
0,22	5	16	48	0,55	13	12	0	0,88	21	7	12
0,23	5	31	12	0,56	13	26	24	0,89	21	21	36
0.24	5	45	36	0 57	13	40	48	0,90	21	36	0
0,25	6	0	0	0,58	13	55	12	0,91	21	50	24
0,26	6	14	24	0,59	14	9	36	0,92	22	4	48
0,27	6	28	48	0,60	14	24	0	0,93	22	19	12
0,28	6	43	12	0,61	14	38	24	0,94	22	33	36
0,29	6	57	36	0,62	14	52	48	0,95	22	48	0
0,30	7	12	0	0,63	15	7	12	0,96	23	2	24
0,31	7	26	24	0,64	15	21	36	0,97	23	16	48
0,32	7	40	48	0,65	15	36	0	0,98	23	31	12
0,33	7	55	12	0,66	15	50	24	0.99	23	45	36
								1,00	24	0	0

B. Ten-thousandths of the Day.

D	m	s	D	m	s	D	m	s
0,0001	0	8,64	0,0034	4	53,76	0,0067	9	38,88
02	0	17,28	35	5	2,40	68	9	47,52
03	0	25,92	36	5	11,04	69	9	56,16
04	0	34,56	37	5	19,68	70	10	4,80
05	0	43,20	38	5	28,32	71	10	13,44
06	0	51,84	39	5	36,96	72	10	22,08
07	1	0,48	40	5	45,60	73	10	30,72
08	1	9,12	41	5	54,24	74	10	39,36
09	1	17,76	42	6	2,88	75	10	48,00
10	1	26,40	43	6	11,52	76	10	56,64
11	1	35,04	44	6	20,16	77	11	5,28
12	1	43,68	45	6	28,80	78	11	13,92
13	1	52,32	46	6	37,44	79	11	22,56
14	2	0,96	47	6	46,08	80	11	31,20
15	2	9,60	48	6	54,72	81	11	39,84
16	2	18,24	49	7	3,36	82	11	48,48
17	2	26,88	50	7	12,00	83	11	57,12
18	2	35,52	51	7	20,64	84	12	5,76
19	2	44,16	52	7	29,28	85	12	14,40
20	2	52,80	53	7	37,92	86	12	23,04
21	3	1,44	54	7	46,56	87	12	31,68
22	3	10,08	55	7	55,20	88	12	40,32
23	3	18,72	56	8	3,84	89	12	48,96
24	3	27,36	57	8	12,48	90	12	57,60
25	3	36,00	58	8	21,12	91	13	6,24
26	3	44,64	59	8	29,76	92	13	14,88
27	3	53,28	60	8	38,40	93	13	23,52
28	4	1,92	61	8	47,04	94	13	32,16
29	4	10,56	62	8	55,68	95	13	40,80
30	4	19,20	63	9	4,32	96	13	49,44
31	4	27,84	64	9	12,96	97	13	58,08
32	4	36,48	65	9	21,60	98	14	6,72
33	4	45,12	66	9	30,24	99	14	15,36
						0,0100	14	24,00

D	s
0,00000	0,000
1	0,864
2	1,728
3	2,592
4	3.456
5	4,320
6	5.184
7	6,048
8	6,912
9	7.776

D	s
0,000000	0,0000
1	0,0864
2	0,1728
3	0,2592
4	0,3456
5	0,4320
6	0,5184
7	0,6048
8	0,6912
9	0,7776

APPENDIX.

FIGURE-CODE EMPLOYED ON THE CONTINENT OF EUROPE.

NOTE.—By the kindness of Professor KREUTZ, of Kiel, the following circular of the Central Bureau of Astronomical Telegrams is reprinted here. So far as I know, it has never been published in America. The system described is perfectly practicable in Europe, where five figures (as 78742) are accepted and paid for as one word; and where the charges for telegrams are moderate. The expense is prohibitory over the transatlantic cables (where three figures are counted as a word), or throughout the United States (where every figure counts as a full word).

The cost of sending a six-word dispatch (giving an exact position) from San Francisco to Cambridge is $1.00 (five francs) by the LICK Observatory Code. By the code in use at Kiel it would be about $2.40 (twelve francs).

E. S. H.

BUREAU CENTRAL
DES DÉPÊCHES ASTRONOMIQUES.

STERNWARTE KIEL, 29 février 1888.

Nous pouvons affirmer, par une expérience de cinq années, que l'emploi des chiffres dans les télégrammes est un mode de correspondance vraiment sûr, tant est faible le nombre des erreurs qui se sont glissées dans les dépêches très nombreuses que nous avons expédiées. D'ailleurs, plusieurs de nos correspondants non-seulement approuvent ce mode de correspondance, mais s'opposent, d'une manière formelle, à l'emploi de tout système plus compliqué qui exigerait l'usage d'un "code"; nous n'apportons donc aucune modification à notre système.

En cas de doute, comme, par exemple, dans le cas d'un désaccord entre les nombres et le nombre de contrôle inscrits dans la dépêche, nous expédierons immédiatement une deuxième dépêche, en réponse au mot: "Répétition." Voici l'adresse du Bureau central: "Sternwarte Kiel."

Nous prions MM. les Correspondants qui nous envoient des communications de vouloir bien s'en tenir au modèle ci-après, ou de nous télégraphier conformément aux termes du "Science Observer Code," système Chandler et Ritchie.

I. Communications de la Découverte d'une Comète ou d'une Planète et de la Position Approchée ou Exacte de l'Astre.

(a) Objet—auteur de la découverte—notes additionnelles—quantième en chiffres—mois—jour de la semaine (à volonté)—(tout cela en temps astronomique).

(b) Groupe de 5 chiffres pour l'époque de l'observation en heures, minutes et dixièmes de minutes (ici et partout ailleurs, on aura soin de mettre des zéros à la place des chiffres qui viennent à manquer).

(c) Spécifier le méridien auquel se rapporte (b).

(d) Groupe de 5 chiffres pour AR. en degrés et minutes.

(e) Groupe de 5 chiffres pour NPD. (distance au pôle nord) en degrés et minutes.

(f) Groupe de 5 chiffres dont le premier, à partir de la gauche, est toujours égal à 7, les quatre derniers donnant les secondes (entières) d'arc de AR. et de NPD. Ce chiffre 7 n'a ici d'autre objet que d'indiquer une position exacte; il doit intervenir dans la formation du nombre de contrôle.

(g) Groupe de 5 chiffres pour le mouvement de l'astre, en 24 heures, en AR., exprimé en degrés et minutes et augmenté de 36000 (c. à. d. 360° 00′).

(h) Groupe de 5 chiffres pour le mouvement en 24 heures en NPD., exprimé en degrés et minutes et augmenté également de 36000 (c. à. d. 360° 00′).

Si le mouvement du corps n'est pas exactement connu, on inscrira au lieu de (g) et (h) "Mouvement inconnu," ou toute autre indication explicite, comme, par exemple, "Mouvement nord-est," "Mouvement nul," etc., ou bien on ne communiquera rien sur le mouvement.

(i) Groupe de 5 chiffres donnant le résultat de l'addition de tous les nombres de cinq chiffres chacun inscrits précédemment. On supprimera dans la somme le chiffre des centaines de mille que pourrait fournir l'addition.

(k) On fera ensuite, si l'on veut, des remarques sur l'éclat de l'astre, planète ou comète. On pourra indiquer la constellation (d'après l'Uranométrie d'Argelander) où la comète a été découverte.

Signature au bas de la dépêche.

II. Communication d'Une Position Observée.

Cette communication sera, en général, plus courte que la précédente, puisque, pour la plupart du temps, (g) et (h) n'y figureront pas. Le paragraphe (a) peut être rendu plus concis par l'emploi du seul mot: "Comète" ou "planète." On peut faire suivre le nombre de contrôle de diverses remarques.

L'ensemble de quatre groupes de 5 chiffres chacun, y compris le nombre de contrôle, indiquent une position approchée; cinq groupes, au contraire, le nombre de contrôle inclus, donnent la position exacte de l'astre. Deux groupes de plus en déterminent le mouvement diurne.

Le dernier groupe de 5 chiffres forme toujours le nombre de contrôle, c'est-à-dire, la somme de tous les nombres de 5 chiffres précédemment inscrits. On devra toujours indiquer ce nombre de contrôle.

Signature au bas de la dépêche.

III. Communication d'Une Position Prédite.

La dépêche donnera les indications des paragraphes (a), (b), (c), (d), (e), (g), (h) et (i) c. à. d. le nombre de contrôle, soit seulement celles des paragraphes (a), (b), (c), (d), (e) et (i); parfois aussi le mot "augmentant" ou "diminuant" (ces mots se rapportant à l'éclat de l'astre).

La teneur du paragraphe (a), le nombre rond du paragraphe (b)—12000 ou 00000—et l'indication du paragraphe (c)—Berlin, Greenwich ou Paris—montreront qu'il s'agit d'une position prédite.

Signature au bas de la dépêche.

IV. Communication de Toute Autre Observation ou Découverte.

En général, les paragraphes qu'on devra communiquer seront: (b) et (c); (d), (e), (i), savoir: époque et lieu de l'observation, AR., NPD. et nombre de contrôle. Le reste du télégramme sera donné explicitement.

Signature au bas de la dépêche.

V. Communication des Éléments d'Une Orbite.

Lorsqu'on voudra communiquer les éléments d'une orbite, on se conformera au modèle suivant:

(a) Objet, avec ou sans le nom de l'auteur, de la découverte—etc.

(b) Le mot: parabole,
ou : ellipse (hyperbole) ; puis un groupe de 5 chiffres (dont 4 décimaux) donnant l'excentricité de l'orbite.

(c) Mois du passage au périhélie.

(d) Groupe de 5 chiffres (dont 3 décimaux) donnant le jour du passage au périhélie, en temps moyen de Berlin.

(e) Groupe de 5 chiffres pour ω, distance du noeud au périhélie, évaluée en degrés et minutes.

(f) Groupe de 5 chiffres pour Ω, longitude du noeud ascendant, évaluée en degrés et minutes.

(g) Groupe de 5 chiffres pour i, inclinaison de l'orbite, évaluée en degrés et minutes.

Dans le cas où le mouvement est rétrograde dans l'orbite, on prendra pour l'inclinaison l'angle supérieur à 90° et l'on évaluera ω en conséquence ; (e), (f), (g) se rapportent à l'équinoxe moyen du commencement de l'année.

(h) Groupe de 5 chiffres, dont quatre décimaux, pour q, distance au périhélie (et non pour log q).

(i) Groupe de 5 chiffres formant le nombre de contrôle. Il est, comme précédemment, la somme de tous les nombres inscrits.

Signature au bas de la dépêche.

EXEMPLE 1.

6 Groupes de chiffres. Découverte, position approchée, indication du mouvement.

Comète Pechüle 16 décembre 06500 Copenhague 28215 07929 36129 35745 14518 brillante, circulaire, condensation. Pechüle.	Une comète a été découverte par Pechüle : déc. 16 6^h $50^m.0$ T. M. Copenhague. AR. = 282° 15′ NPD. = 79 29 Mouv. diurne en AR. : +1° 29′, en NPD. : −2° 15′. Comète brillante, circulaire avec condensation. *Pechüle.*

EXEMPLE 2.

5 Groupes de chiffres. Position exacte.

Comète 17 février 12287 Paris 11555 10229 74702 08773 Bigourdan. Mouchez.	La nouvelle comète a été observée par Bigourdan : février 17 12^h $28^m.7$ T. M. Paris AR. app = 115° 55′ 47″ NPD. app. = 102 29 2 *Mouchez.*

EXEMPLE 3.

7 Groupes de chiffres. Découverte, position exacte, indication du mouvement.

Planète Palisa 21 septembre 13343 Vienne 34858 09715 75525 35947 36007 05395 douzième.
Weiss.

Une planète de la 12e grandeur a été découverte par Palisa. Position de la planète:
septembre 21 $13^h 34^m.3$ T.M. Vienne
AR. app. = 348° 58′ 55″
NPD. app. = 97 15 25
Mouv. diurne en AR.: —13′, en NPD.: +7′.
Weiss.

EXEMPLE 4.

6 Groupes de chiffres. Position prédite, indication du mouvement.

Comète 22 août 12000 Berlin 17142 04733 36429 36301 06605 augmentant.
Hepperger.

La nouvelle comète occupe le 22 août, minuit moyen de Berlin, la position suivante:
AR. = 171° 42′
NPD. = 47 33
Mouv. diurne en AR.: +4° 29′, en NPD.: +3° 1′.
L'éclat de la comète va en augmentant.
Hepperger.

REMARQUE.—La date mentionnée dans le télégramme sera, en général, antérieure à celle de la position prédite.

EXEMPLE 5.

6 Groupes de chiffres. Eléments paraboliques d'une comète.

Comète parabole novembre 19752 11755 18121 14448 19261 83337.
Oppenheim.

Eléments paraboliques de la nouvelle comète:
T= novembre 19.752 T.M. Berlin
ω = 117° 55′ ⎫ Equinoxe moyen
Ω = 181 21 ⎬ du commencement
i = 144 48 ⎭ de l'année.
q = 1.9261
Oppenheim.

EXEMPLE 6.

7 Groupes de chiffres. Eléments elliptiques d'une comète.

Comète ellipse 09902 novembre 19779 11757 18123 14449 19250 93260.
Oppenheim.

Eléments elliptiques de la nouvelle comète:
T= novembre 19.779 T. M. Berlin
ω = 117° 57′ ⎫ Equinoxe moyen
Ω = 181 23 ⎬ du commencement
i = 144 49 ⎭ de l'année.
q = 1.9250
e = 0.9902
Oppenheim.

REMARQUE.—Les exemples 5 et 6 se rapportent aux éléments paraboliques et elliptiques de la comète 1881 VIII communiqués par M. le Dr. S. Oppenheim dans les A. N. 2692.

A. Krueger.

NOTICE.

The attention of new members is called to Article VIII of the By-Laws, which provides that the annual subscription, paid on election, covers the *calendar* year only. Subsequent annual payments are due on January 1st of each succeeding calendar year. This rule is necessary in order to make our book-keeping as simple as possible. Dues sent by mail should be directed to Astronomical Society of the Pacific 819 Market Street, San Francisco.

It is intended that each member of the Society shall receive a copy of each one of the *Publications* for the year in which he was elected to membership and for all subsequent years. If there have been (unfortunately) any omissions in this matter, it is requested that the Secretaries be at once notified, in order that the missing numbers may be supplied. Members are requested to preserve the copies of the *Publications* of the Society as sent to them. Once each year a title-page and contents of the preceding numbers will also be sent to the members, who can then bind the numbers together into a volume. Complete volumes for past years will also be supplied, to members only, so far as the stock in hand is sufficient, on the payment of two dollars to either of the Secretaries. Any non-resident member within the United States can obtain books from the Society's library by sending his library card with ten cents in stamps to the Secretary A. S. P., 819 Market Street, San Francisco, who will return the book and the card.

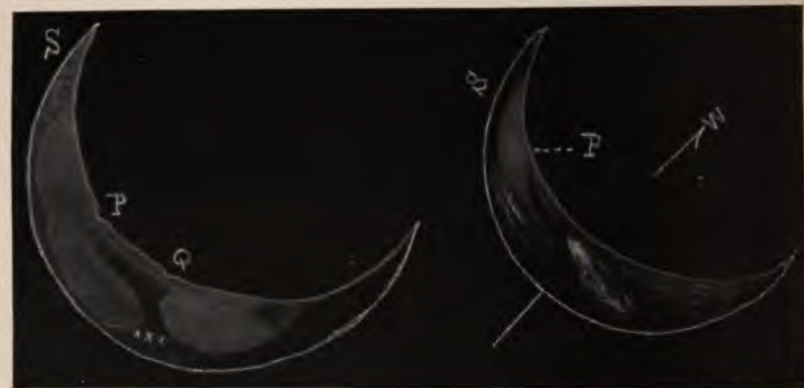
The Committee on Publication desires to say that the order in which papers are printed in the *Publications* is decided simply by convenience. In a general way, those papers are printed first which are earliest accepted for publication. It is not possible to send proof sheets of papers to be printed to authors whose residence is not within the United States. The responsibility for the views expressed in the papers printed rests with the writers, and is not assumed by the Society itself.

The titles of papers for reading should be communicated to either of the Secretaries as early as possible, as well as any changes in addresses. The Secretary in San Francisco will send to any member of the Society suitable stationery, stamped with the seal of the Society, at cost price, as follows: a block of letter paper, 40 cents; of note paper, 25 cents; a package of envelopes, 25 cents. These prices include postage, and should be remitted by money-order or in U. S. postage stamps. The sendings are at the risk of the member.

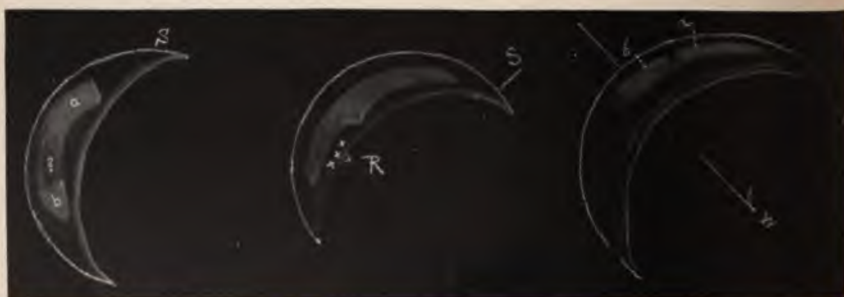
Those members who propose to attend the meetings at Mount Hamilton during the summer should communicate with "The Secretary Astronomical Society of the Pacific" at the rooms of the Society, 819 Market Street, San Francisco, in order that arrangements may be made for transportation, lodging, etc.

PUBLICATIONS ISSUED BI-MONTHLY.

(February, April, June, August, October, December.)



1889, May 29, 3h 53m, Sid. T. 36 inch. 1889, May 29, 3h 18m, Sid. T 12-inch.



1889, June 11, 23h. P. S. T. 12-inch. 1889, June 10, 16h 50m, P. S. T. 12-inch. 1889, June 3, 16h 30m, P. S. T. 12-inch.

E. S. H. delt.

DIAGRAMS OF THE PLANET *VENUS.*

PUBLICATIONS

Astronomical Society of the Pacific.

VOL. VIII. SAN FRANCISCO, CALIFORNIA, JUNE 1, 1896. NO. 50.

TABLES OF THE ELEMENTS OF COMET ORBITS.

COMPILED BY W. C. WINLOCK.

The following tables of the elements of cometary orbits have been prepared at the suggestion of Professor HOLDEN, to facilitate comparison of the orbits of newly discovered comets with those already known.

The data for Table I had been taken from a number of sources, but largely from Dr. VALENTINER'S interesting little book "Kometen und Meteore," * before the lately published and most complete and admirable work of Dr. GALLE † came into my hands, when the latter served at once as a check upon the older lists.

Table I.—Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.—The approximate elements are here given of the orbits of all comets that have been sufficiently determined to the end of the year 1895; arranged according to the date of perihelion passage.

The current numbers in the first column are those adopted by Dr. GALLE in his latest list (to avoid the unnecessary introduction of new notation), and serve for convenient reference from the succeeding tables. A consecutive series of numbers is used throughout, so that the periodic comets receive a new number at each observed return. Each of the well-known periodic comets

* "Die Kometen und Meteore," von W. VALENTINER. 240 pages, 12mo, Leipzig, 1884.

† "Verzeichniss der Elemente der bisher berechneten Cometenbahnen nebst Anmerkungen und Literatur-Nachweisen zum Jahre 1894," von J. G. GALLE. 20 + 315 pages, 4to, Leipzig, 1894.

is designated as well by a special name, usually that of the discoverer, abbreviated as follows (see Col. 1, Table I):

d'A = d'ARREST'S comet.
B = BIELA'S (the two components, B^A and B^B).
BR = BRORSEN'S comet.
E = ENCKE'S comet.
F = FAYE'S comet.
FI = FINLAY'S comet.
H = HALLEY'S comet.
O = OLBERS' comet.
P-Bs = PONS-BROOKS comet.
T_1 = TEMPEL_1 comet.
T_2 = TEMPEL_2 comet.
T_3-S = TEMPEL_3-SWIFT comet.
TU = TUTTLE'S comet.
W = WINNECKE'S comet.
WO = WOLF'S comet.

The orbit elements are given in succeeding columns as follows:

T = time of perihelion passage.
ω = "argument of perihelion" $= \pi - \Omega$, where π = longitude of perihelion.
Ω = longitude of the ascending node.
i = inclination of the comet's orbit to the ecliptic (counted from 0° to 180°).
q = distance of the comet from the Sun at perihelion, the mean distance of the Earth from the Sun being taken as 1.
a = semi-major axis of the orbit, the mean distance of the Earth from the Sun being 1.
U = period of revolution about the Sun, in years.
e = eccentricity of orbit.

Where more than one comet is recorded in a year, the Roman numerals I, II, III, etc., indicate the order in which they passed perihelion. The month, day, and tenth of a day of perihelion passage (T) are also given, the time being strictly that of the Paris meridian, as in most lists of comets, but the correction to reduce this to the Greenwich meridian is entirely inappreciable here, amounting to but -0.006 of a day.

The abbreviations for the months are:

Ja = January.	Jl = July.
F = February.	Ag = August.
Mr = March	S = September.
Ap = April.	O = October.
My = May	N = November.
Je = June.	D = December.

The angle ω, which has been called the "argument of perihelion," has been used in the elements, as it has a simpler geometrical signification than the longitude of perihelion π, and is now much more commonly used by computers.

The inclination i, as proposed by GAUSS, is counted from 0° to 180°, avoiding the necessity of designating an orbit as "Direct" or "Retrograde."

The last column of Table I gives the discoverer's name.

Table II.—Comets arranged in order of ω.—The comets catalogued in Table I are here arranged according to the "argument of perihelion," ω. The first column gives the limiting values of ω, and the second the reference numbers to Table I, or for well-known periodic comets the adopted abbreviation. The comet numbers within the given limits for ω are also arranged, approximately, but not strictly, according to the increasing values of ω.

Table III.—Comets arranged in the order of the longitude of the ascending node, ☊.—The first column gives limiting values of ☊, the second column reference numbers to the complete elements in Table I.

Table IV.—Comets arranged in order of inclination, i.—In the first column the values of i are given for each degree from 0° to 180°, the second column reference numbers to Table I of all comets having inclinations within each degree; e. g., i =40° includes inclinations from 40°.0 to 40°.9.

Table V.—Comets arranged in order of perihelion distance, q, in terms of the Earth's mean distance from the Sun.

Table VI.—Comets arranged in order of semi-major axis, a, in terms of the Earth's mean distance from the Sun.

Table VII.—Comets arranged in order of the period of revolution, U, about the Sun, expressed in years.

Table VIII.—Comets arranged in order of eccentricity, e.

TABLE I. APPROXIMATE ELEMENTS OF ALL COMPUTED ORBITS OF COMETS FROM B. C. 372 TO A. D. 1896.

NUMBER.	T		ω	☊	i	q	a	U	e	DISCOVERER.
	B. C.	Old Style.								
1	371	Winter	120.°	270° to 330°	90° to 150°	Small				
2	137	Ap. 29.	350.	220.	160.	1.010				
3	69	Jl.	150.	165.	70.	0.79				
4	12	O. 8.8	108.	28.	170.	0.583				
	A. D.	Old Style.								
5	66	Ja. 14.2	67.7	32.7	139.5	0.445				
6	141	Mr. 29.1	120.9	12.8	163.0	0.720				
7	240	N. 10.	82.	189.	44.	0.372				
8	539	O. 20.6	255.5 or 75.5	58 or 238	10.0	0.341				
9	565	Jl. 14.5	79.5	159.5	121.0	0.832				
10	568	Ag. 29.3	24.3	294.2	4.1	0.907				
11	574	Ap. 7.3	15.4	128.3	46.5	0.963				
12	770	Je. 6.6	86.8	88.9	120.5	0.603				
13	837	Mr. 1.0	277.5	206.5	168 or 170	0.580				
14	961	D. 30.2	82.6	350.6	100.5	0.552				
15	989	S. 12.0	180.	84.	163.	0.568				
16	1006	Mr. 22.	93 to 94	38.	162.5	0.583				
17	1066	Ap. 1.0	120.9	25.8	163.0	0.720				
18	1092	F. 15.0	30.7	125.7	28.9	0.928				
19	1097	S. 21.9	125.0	207.5	73.5	0.738				
20	1231	Ja. 30.3	121.3	13.5	6.1	0.948				

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	T		ω	☊	i	q	a	U	e	Discoverer.
26	1362	Mr. 2.3	10.	237.	148.	0.470	. . . .	. . . . .	. . .	
27	1366	O. 21.5	169.4	217.4	152.4	0.980	. . . .	. . . . .	. . .	
28 H.	1378	N. 8.8	107.8	47.3	162.1	0.583	. . . .	. . . . .	. . .	
29	1385	O. 16.3	166.7	268.5	127.8	0.774	. . . .	. . . . .	. . .	
30	1402	Mr. 21.	91.	117.	55.	0.380	. . . .	. . . . .	. . .	
31	1433	N. 7.8	189.3	96.3	104.0	0.493	. . . .	. . . . .	. . .	
32	1449	D. 9.4	356.9	261.3	155.7	0.327	. . . .	. . . . .	. . .	
33 H.	1456	Je. 8.2	104.8	43.8	162.4	0.580	17.97	75.	0.968	
34	1457 I	Ja. 18.0	194.9	249.7	13.3	0.703	. . . .	. . . . .	. . .	
35	1457 II	Ag. 8.0	185.1	184.4	9.9	0.760	. . . .	. . . . .	. . .	
36	1468	O. 7.4	69.7	71.1	142.0	0.830	. . . .	. . . . .	. . .	
37	1472	F. 29.9	246.1	285.9	170.8	0.486	. . . .	. . . . .	. . .	Regiomontanus.
38	1490	D. 24.5	129.9	288.8	51.6	0.738	. . . .	. . . . .	. . .	
39	1499	S. 6.2	33.5	326.5	21.	0.954	. . . .	. . . . .	. . .	
40	1500	My. 17.	20.	310.	105.	1.400	. . . .	. . . . .	. . .	
41	1506	S. 3.7	242.2	132.8	135.0	0.386	. . . .	. . . . .	. . .	
42 H.	1531	Ag. 25.8	104.3	45.5	163.0	0.580	17.79	75.0	0.967	Apianus.
43	1532	O. 18.3	24.4	87.4	32.6	0.519	. . . .	. . . . .	. . .	Fracastor.
44	1533	Je. 14.9	278.4	299.3	28.2	0.327	. . . .	. . . . .	. . .	
45	1556	Ap. 22.2	100.9	175.2	32.4	0.491	. . . .	. . . . .	. . .	
46	1558	S. 13.6	119.6	335.0	110.9	0.280	. . . .	. . . . .	. . .	
47	1577	O. 27.0	255.6	25.3	104.8	0.177	. . . .	. . . . .	. . .	Tycho Brahe.
48	1580	N. 28.5	89.3	19.1	64.6	0.602	. . . .	. . . . .	. . .	Moestlin.
49	1582	My. 6.4	333.0	229.3	119.2	0.168	. . . .	. . . . .	. . .	Tycho Brahe.
50	1585	New Style O. 8.0	331.4	37.7	6.1	1.095	. . . .	. . . . .	. . .	William IV v. Hesse.

TABLE I—*(Continued).* Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	*T*		ω	☊	i	q	a	U	e	DISCOVERER.
51	1590	F. 8.0	307.7	165.6	150.5	0.568	....	....	...	Tycho Brahe.
52	1593	Jl. 18.6	12.1	164.2	88.0	0.089	....	....	...	Ripensis.
53	1596	Jl. 25.2	59.4	330.3	128.0	0.567	....	....	...	
54 H.	1607	O. 26.7	107.0	48.7	162.8	0.588	17.87	75.5	0.967	Harriot.
55	1618 I	Ag. 17.1	24.9	293.4	21.5	0.513	....	....	...	Kepler.
56	1618 II	N. 8.4	287.4	75.7	37.2	0.390	....	....	...	Kirch.
57	1652	N. 12.7	300.1	88.2	79.5	0.847	....	....	...	Hevelius.
58	1661	Ja. 26.9	33.4	81.9	33.0	0.443	....	....	...	Hevelius.
59	1664	D. 4.5	310.6	81.3	158.7	1.026	....	....	...	
60	1665	Ap. 24.2	156.1	228.0	103.9	0.106	....	....	...	Hevelius.
61	1668	F. 28.8	80.3	357.3	144.0	0.005	....	....	...	Ægidius.
62	1672	Mr. 1.5	109.6	298.1	82.9	0.695	....	...	...	
63	1677	My. 6.0	99.2	236.8	100.9	0.281	....	....	...	Hevelius.
64	1678	Ag. 18.3	159.5	163.3	2.9	1.145	3.070	5.38	0.627	Lahire.
65	1680	D. 18.0	350.6	272.2	60.7	0.006	426.7	8814.	1.000	Kirch.
66 H.	1682	S. 14.8	109.3	51.2	162.3	0.583	18.17	77.5	0.968	
67	1683	Jl. 13.1	87.8	173.4	96.8	0.560	....	....	...	Flamsteed.
68	1684	Je. 8.3	330.3	268.2	65.4	0.958	....	....	...	Bianchini.
69	1686	S. 15.8	81.9	354.1	34.9	0.336	....	....	...	
70	1689	N. 30.2	78.2	279.4	63.2	0.064	....	....	...	Richaud.
71	1695	N. 9.7	204.	216.	22.	0.844	....	....	...	Jacob.
72	1698	O. 17.0	151.2	65.9	169.1	0.729	....	....	...	Lahire.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				de Fontenay

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	*T*	ω	☊	*i*	*q*	*a*	*U*	*e*	Discoverer.
77	1707 D. 12.0	27.1	52.8	88.6	0.860	. . . .	. . . . .	. . .	Manfredi.
78	1718 Ja. 14.9	6.3	127.9	148.9	1.025	. . . .	. . . . .	. . .	Kirch.
79	1723 S. 27.6	331.4	14.2	130.0	0.999	. . . .	. . . . .	. . .	
80	1729 Je. 16.2	10.4	310.6	77.1	4.051	. . . .	. . . . .	. . .	Sarabat.
81	1737 I Ja. 30.4	99.5	226.4	18.3	0.223	. . . .	. . . . .	. . .	
82	1737 II Je. 2.2	129.9	132.1	61.9	0.835	. . . .	. . . . .	. . .	
83	1739 Je. 17.4	104.8	207.4	124.3	0.674	. . . .	. . . . .	. . .	Zanotti.
84	1742 F. 8.6	328.5	185.2	112.5	0.770	. . . .	. . . . .	. . .	Grant.
85	1743 I Ja. 8.2	6.4	86.9	1.9	0.862	3.10	6.73	0.721	Grischow.
86	1743 II S. 20.7	119.0	6.0	134.4	0.523	. . . .	. . . . .	. .	Klinkenberg.
87	1744 Mr. 1.3	151.4	45.8	47.1	0.222	. . . .	. . . . .	. . .	Klinkenberg.
88	1747 Mr. 3.3	230.3	147.3	100.9	2.199	. . . .	. . . . .	. . .	Chéseaux.
89	1748 I Ap. 28.8	17.5	232.9	94.5	0.840	. . . .	. . . . .	. . .	
90	1748 II Je. 18.9	245.6	33.1	67.1	0.625	. . . .	. . . .	. . .	Klinkenberg.
91	1757 O. 21.4	268.5	214.1	12.7	0.339	. . . .	. . . . .	. . .	Bradley.
92	1758 Je. 11.1	36.8	230.8	68.3	0.215	. . . .	. . . . .	. . .	de la Nux.
93 H.	1759 I Mr. 12.6	110.6	53.8	162.4	0.585	18.09	76.9	0.968	Palitzsch.
94	1759 II N. 27.1	273.7	139.7	79.0	0.799	. . . .	. . . . .	. . .	Messier.
95	1759 III D. 16.8	301.4	79.8	175.1	0.966	. . . .	. . . . .	. . .	
96	1762 My. 28.3	115.5	348.6	85.6	1.009	. . . .	. . . . .	. . .	Klinkenberg.
97	1763 N. 1.9	88.6	356.4	72.5	0.498	377.	7335.	0.999	Messier.
98	1764 F. 12.6	104.8	120.1	127.1	0.555	. . . .	. . . . .	. . .	Messier.
99	1766 I F. 17.4	100.9	244.2	139.2	0.505	. . . .	. . . . .	. . .	Messier.
100	1766 II Ap. 27.0	177.0	74.2	8.0	0.399	2.934	5.025	0.864	Helfenzrieder.
101	1769 O. 7.6	329.1	175.1	40.8	0.123	163.5	2090.	0.999	Messier.

TABLE I—*(Continued)*. Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	T		ω	☊	i	q	a	U	e	DISCOVERER.
102	1770 I	Ag. 13.5	224.3	132.0	1.6	0.674	3.163	5.626	0.786	Messier.
103	1770 II	N. 22.2	260.3	108.7	148.6	0.528	. . . .	. . . .	. . .	
104	1771	Ap. 19.1	76.1	27.9	11.3	0.902	. . . .	. . . .		Messier.
105 B.	1772	F. 16.7	213.0	257.3	17.1	0.986	3.58	6.77	0.725	Montaigne.
106	1773	S. 5.6	314.1	121.1	61.2	1.127	. . . .	. . . .	. . .	Messier.
107	1774	Ag. 15.8	136.7	180.7	83.3	1.433	. . . .	. . . .	. . .	Montaigne.
108	1779	Ja. 4.1	62.1	25.1	32.5	0.713	. . . .	. . . .	. . .	Bode.
109	1780 I	S. 30.8	237.8	124.2	126.2	0.099	. . . .	. . . .	. . .	Messier.
110	1780 II	N. 28.9	254.1	141.0	107.9	0.515	. . . .	. . . .	. . .	Montaigne, Olbers.
111	1781 I	Jl. 7.2	156.2	83.0	81.7	0.776	. . . .	. . . .	. . .	Méchain.
112	1781 II	N. 29.5	61.3	77.4	152.8	0.961	. . . .	. . . .	. . .	Méchain.
113	1783	N. 19.9	354.6	55.7	45.1	1.459	3.260	5.888	0.552	Pigott.
114	1784	Ja. 21.2	336.1	56.8	128.8	0.708	. . . .	. . . .	. . .	de la Nux.
115	1785 I	Ja. 27.3	205.7	264.2	70.2	1.143	. . . .	. . . .	. . .	Messier, Méchain.
116	1785 II	Ap. 8.4	127.1	64.6	92.5	0.427	. . . .	. . . .	. . .	Méchain.
117 E.	1786 I	Ja. 30.9	182.5	334.1	13.6	0.335	2.208	3.281	0.848	Méchain.
118	1786 II	Jl. 8.6	323.2	195.4	51.0	0.394	. . . .	. . . .	. . .	C. Herschel.
119	1787	My. 10.8	99.1	106.9	131.7	0.349	. . . .	. . . .	. .	Méchain.
120	1788 I	N. 10.3	57.8	156.9	167.5	1.063	. . . .	. . . .	. . .	Messier.
121	1788 II	N. 20.3	30.4	352.4	64.5	0.757	. . . .	. . . .	. . .	C. Herschel.
122	1790 I	Ja. 16.8	114.4	172.8	150.3	0.747	. . . .	. . . .	. . .	C. Herschel.
123 Tu.	1790 II	Ja. 30.9	207.1	268.6	54.1	1.044	5.78	13.90	0.819	Méchain.
124	1790 III	My. 21.2	119.5	33.2	116.1	0.798	. . . .	. . . .	. . .	C. Herschel.
125	1792 I	Ja. 13.5	154.4	190.7	140.2	1.293	. . . .	. . . .	. . .	C. Herschel.
126	1792 II	D. 27.3	147.3	283.3	131.0	0.966	. . . .	. . . .	. . .	Gregory. Messier.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	T		ω	☊	i	q	a	U	e	Discoverer.
128	1793 II	N. 19.5	69.3	2.3	51.9	1.504	. . . .	. . . . .	. . .	Perny.
129 E	1795	D. 21.4	182.0	334.7	13.7	0.334	2.213	3.292	0.849	C. Herschel.
130	1796	Ap. 2.8	184.3	17.0	115.1	1.578	. . . .	. . . . .	. . .	Olbers.
131	1797	Jl. 9.1	279.8	329.3	129.3	0.527	. . . .	. . . . .	. . .	Bouvard, C. Herschel, Lee.
132	1798 I	Ap. 4.5	342.9	122.2	43.7	0.485	. . . .	. . . . .	. . .	Messier.
133	1798 II	D. 31.5	215.0	249.5	137.6	0.780	. . . .	. . . . .	. . .	Bouvard.
134	1799 I	S. 7.2	95 8	99.5	129.1	0.840	. . . .	. . . . .	. . .	Méchain.
135	1799 II	D. 25.9	136.5	326.8	103.0	0.626	. . . .	. . . . .	. . .	Méchain.
136	1801	Ag. 8.6	219.8	42.5	159.2	0.256	. . . .	. . . . .	. . .	Pons, Messier.
137	1802	S. 9.9	21.9	310.3	57.0	1.094	. . . .	. . . . .	. . .	Pons.
138	1804	F. 13.6	331.9	176.8	56.5	1.071	. . . .	. . . . .	. . .	Pons.
139 E.	1805	N. 21.5	182.5	334.3	13.6	0.340	2.213	3.292	0.846	Bouvard, Pons, Huth.
140 B.	1806 I	Ja. 2.0	218.2	251.3	13.6	0.907	3.567	6.737	0.746	Pons.
141	1806 II	D. 28.9	225.3	322.4	145.0	1.082	. . . .	. . . . .	1.010	Pons.
142	1807	S. 18.7	4.1	266.8	63 2	0.646	143.2	1714.	0.995	Parisi.
143	1808 I	My. 13.0	253.8	323.0	134.3	0.390	. . . .	. . . . .	. . .	Pons.
144	1808 II	Jl. 12.2	131.5	24.2	140.7	0.608	. . . .	. . . . .	. . .	Pons.
145	1810	O. 6.2	114.9	308.8	62.9	0.970	. . . .	. . . . .	. . .	Pons.
146	1811 I	S. 12.3	65.4	140.4	107.0	1.035	212.3	3094.	0.995	Flaugergues.
147	1811 II	N. 11.0	314.4	93.0	31.3	1.582	91.51	875.	0.983	Pons.
148	1812	S. 15.3	199.3	253.0	74.0	0.777	17.5	73.	0.956	Pons.
149	1813 I	Mr. 4.5	350.9	60.8	158.8	0.699	. . . .	. . . . .	. . .	Pons.
150	1813 II	My. 19.5	205.1	42.7	98.9	1.215	. . . .	. . . . .	. . .	Pons.
151 O.	1815	Ap. 26.0	65.6	83.5	44.5	1.213	17 63	74.	0.931	Olbers.
152	1816	Mr. 1.4	304.3	323.2	43.1	0.049	. . . .	. . . . .	. . .	Pons.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	*T*			ω	☊	*i*	*q*	*a*	*U*	*e*	Discoverer.
153	1818	I	F. 3 2	180.3	256.0	34.2	0.696	. . . .	. . . .	. . .	Pons.
154	1818	II	F. 26.0	112.3	70.4	89.7	1.198	. . . .	. . . .	. . .	Pons.
155	1818	III	D. 5.0	348.2	90.0	117.0	0.855	. . . .	. . . .	1.012	Pons.
156 E.	1819	I	Ja. 28.0	182.4	334.6	13.6	0.335	2.214	3.295	0.849	Pons.
157	1819	II	Je. 27.7	13.4	273.7	80.7	0.341	. . . .	. . . .	. . .	Tralles.
158 W.	1819	III	Jl. 18.9	161.5	113.2	10.7	0.774	3.160	5.618	0.755	Pons.
159	1819	IV	N. 20.3	350 1	77.2	9.0	0.893	2.849	4.810	0.687	Blanpain, Pons.
160	1821		Mr. 21.5	169.2	48.7	106.4	0.092	. . . .	. . . .	. . .	Nicollet, Pons.
161	1822	I	My. 5.6	344.7	177.4	126.4	0.504	. . . .	. . . .	. . .	Gambart.
162 E.	1822	II	My. 24.0	182.8	334.4	13.3	0.346	2.224	3.318	0.845	
163	1822	III	Jl. 15.9	237.7	97.7	143.7	0.847	. . . .	. . . .	. . .	Pons.
164	1822	IV	O. 23.8	181.1	92.7	127.3	1.145	309.7	5449.	0.996	Pons.
165	1823		D. 9.5	28.5	303.1	103.8	0.227	. . . .	. . . .	. . .	Köhler.
166	1824	I	Jl. 11.5	334.0	234.3	125.4	0.591	. . . .	. . . .	. . .	Rümker.
167	1824	II	S. 29.1	85.3	279.3	54.6	1.050	. . . .	. . . .	. . .	Scheithauer.
168	1825	I	My. 30.6	106.2	20.1	123.3	0.889	. . . .	. . . .	. . .	Gambart.
169	1825	II	Ag. 18.7	177.3	192.9	89.7	0.883	. . . .	. . . .	. . .	Pons.
170 E.	1825	III	S. 16.3	182.8	334.5	13.4	0.345	2.233	3.315	0.845	
171	1825	IV	D. 10.7	256.9	215.7	146.5	1.241	271.4	4472.	0.995	Pons.
172 B.	1826	I	Mr. 18.4	218.3	251 5	13.6	0.903	3.561	6.720	0.747	Biela.
173	1826	II	Ap. 21.9	279.4	197.6	40.0	2.008	. . . .	. . . .	. . .	Pons.
174	1826	III	Ap. 29.0	4.7	40.5	174.7	0.188	. . . .	. . . .	. . .	Flaugergues.
175	1826	IV	O. [illegible]	[illegible]	44.1	26.0	[illegible]				Pons

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	T	ω	☊	i	q	a	U	e	DISCOVERER.
179	1827 III S. 11.7	258.7	149.7	125.9	0.138	189.6	2611.	0.999	Pons.
180 E.	1829 Ja. 9.7	182.8	334.5	13.3	0.346	2.224	3.316	0.845	
181	1830 I Ap. 9.3	5.8	206.4	21.3	0.921	. . . .	. . . .	. . .	d'Abbadie.
182	1830 II D. 27.7	26.9	337 9	135.2	0.126	. . . .	. . . .	. . .	Herapath.
183 E.	1832 I My. 4.0	182.8	334.5	13.4	0.343	2.222	3.312	0.845	
184	1832 II S. 25 6	204.6	72.5	136.7	1.183	. . . .	. . . .	. . .	Gambart.
185 B.	1832 III N. 26.1	221.8	248.3	13.2	0.879	3.537	6.652	0.751	
186	1833 S. 10.4	260.9	323.5	7.3	0.464	. . . .	. . . .	. . .	Dunlop.
187	1834 Ap. 2.8	50.2	226.6	6.0	0.513	. . . .	. . . .	. . .	Gambart.
188	1835 I Mr. 27.6	210.6	58.3	170.9	2.041	. . . .	. . . .	. . .	Boguslawski.
189 E.	1835 II Ag. 26.4	182.8	334.6	13.4	0.344	2.223	3.314	0.845	
190 H.	1835 III N. 15.9	110.6	55.2	162.2	0.587	17.99	76.29	0.967	
191 E.	1838 D. 19.0	182.8	334.6	13.4	0.344	2.222	3.313	0.845	
192	1840 I Ja. 4.5	72.2	120.0	53.1	0.618	. . . .	. . . .	0.999+	Galle.
193	1840 II Mr. 13.1	156 6	236.8	120.8	1.221	243.	3789.	0.995	Galle.
194	1840 III Ap. 2.4	138.0	186.0	79.9	0.748	. . . .	. . . .	. . .	Galle.
195	1840 IV N. 13.7	133.6	248.9	58.0	1.481	51.3	367.2	0.971	Bremiker.
196 E.	1842 I Ap. 12.0	182.8	334.7	13.3	0.345	2.223	3.314	0.845	
197	1842 II D. 16.0	240.5	207.8	106.4	0.504	. . . .	. . . .	. . .	Laugier.
198	1843 I F. 27.4	82.6	1.3	144.3	0.006	64.03	512.	0.999+	
199	1843 II My. 6.1	124 2	157.2	52.7	1.615	. . . .	. . . .	. . .	Mauvais.
200 F.	1843 III O. 17.1	200.1	209.5	11.4	1.693	3.812	7.442	0.556	Faye.
201	1844 I S. 2.5	278.7	63.8	2.9	1.186	3.100	5.459	0.617	de Vico.
202	1844 II O. 17.4	211.3	31.7	131.4	0.855	. . . .	. . . .	. . .	Mauvais.
203	1844 III D. 13.7	177.7	118.3	45.6	0.252	. . . .	. . . .	1.000+	

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number	T			ω	☊	i	q	a	U	e	Discoverer.
204	1845	I	Ja. 8.2	114.6	336.7	46.9	0.905	. . . .	. . . .	. . .	d'Arrest.
205	1845	II	Ap. 21.0	205.4	347.1	56.4	1.255	. . . .	. . . .	. . .	de Vico.
206	1845	III	Je. 5.7	75.8	337.8	131.3	0.402	39.66	249.8	0.990	Colla.
207 E.	1845	IV	Ag. 9.6	183.4	334.3	13.1	0.338	2.216	3.300	0.847	
208	1846	I	Ja. 22.1	338.0	111.1	47.4	1.481	194.9	2721.	0.992	de Vico.
209 B.[A]	1846	II	F. 11.0	223.1	245.9	12.6	0.856	3.520	6.603	0.757	
209 B.[B]	1846	II	F. 11.1	223.1	245.9	12.6	0.856	3.519	6.601	0.757	
210 Br.	1846	III	F. 25.4	13.8	102.7	30.9	0.650	3.142	5.569	0.793	Brorsen.
211	1846	IV	Mr. 5.6	12.9	77.6	85.1	0.664	17.90	75.7	0.963	de Vico.
212	1846	V	My. 27.9	78.7	161.3	122.4	1.376	. . . .	. . . .	. . .	de Vico, Hind.
213	1846	VI	Je. 1.1	339.6	260.4	30.7	1.529	5.635	13.38	0.729	Peters.
214	1846	VII	Je. 5.5	99.8	261.9	150.7	0.634	62.99	500.	0.990	Brorsen.
215	1846	VIII	O. 29.8	94.0	4.7	49.7	0.831	. . . .	. . . .	. . .	de Vico.
216	1847	I	Mr. 30.3	254.3	21.7	48.6	0.043	470.9	10219.	0.999+	Hind.
217	1847	II	Je. 4.7	32.3	174.0	100.4	2.115	. . . .	. . . .	. . .	Colla.
218	1847	III	Ag. 9.3	91.5	338.3	96.6	1.767	1251.	44229.	0.999	Mauvais.
219	1847	IV	Ag. 9.4	55.4	76.7	147.4	1.485	. . . .	. . . .	. . .	Schweizer.
220	1847	V	S. 9.5	129.3	309.8	19.1	0.488	18.7	81.1	0.974	Brorsen.
221	1847	VI	N. 14.4	276.6	190.8	108.2	0.329	. . . .	. . . .	1.000+	Miss Mitchell.
222	1848	I	S. 8.1	261.0	211.5	95.6	0.320	. . . .	. . . .	. . .	Petersen.
223 E.	1848	II	N. 26.1	183.4	334.4	13.1	0.337	2.215	3.296	0.848	
224	1849	I	Ja. 19.4	208.0	215.2	85.0	0.960	. . . .	. . . .	. .	Petersen.
225	1849	II	My. 26.5	33.2	202.5	67.2	1.160	. . . .	. . . .	1.001	Goujon.
226	1849	III	Je. 8.2	236.6	30.5	66.9	0.894	412.	8375.	0.998	Schweizer.
227	1850	I	Jl. 23.5	180.5	92.9	68.2	1.081	942.	28909.	0.999	Petersen.
228	1850	II	O. 19.3	243.2	206.0	40.1	0.565	. . . .	. . . .	. . .	Bond.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	T	ω	☊	i	q	a	U	e	Discoverer.
229 F.	1851 I Ap. 1.9	200.2	209.5	11.4	1.700	3.819	7.462	0.555	
230 d'A.	1851 II Jl. 8.7	174.5	148.4	13.9	1.173	3.444	6.390	0.659	d'Arrest.
231	1851 III Ag. 26.2	87.3	223.7	38.2	0.984	313.	5544.	0.997	Brorsen.
232	1851 IV S. 30.8	294.4	44.4	74.0	0.142	. . . .	. . . .	. . .	Brorsen.
233 E.	1852 I Mr. 14.7	183.5	334.4	13.1	0.337	2.215	3.297	0.848	
234	1852 II Ap. 19.6	37.2	317.2	131.1	0.905	. . . .	. . . .	. . .	Chacornac.
235 B.[A]	1852 III S. 23.7	223.3	245.9	12.6	0.861	3.526	6.621	0.756	
235 B.[B]	1852 III S. 23.1	223.3	245.9	12.6	0.861	3.525	6.619	0.756	
236	1852 IV O. 12.8	57.1	346.2	40.9	1.250	15.44	60.7	0.919	Westphal.
237	1853 I F. 24.0	275.8	69.6	159.7	1.092	. . . .	. . . .	. . .	Secchi.
238	1853 II My. 9.8	199.2	41.0	122.2	0.909	84.9	782.3	0.989	Schweizer.
239	1853 III S. 1.7	170.4	140.5	61.5	0.307	. . . .	. . . .	. . .	Klinkerfues.
240	1853 IV O. 16.6	277.8	220.1	119.0	0.173	. . . .	. . . .	1.001	Bruhns.
241	1854 I Ja. 3.9	170.9	227.0	113.9	2.045	. . . .	. . . .	. . .	van Arsdale.
242	1854 II Mr. 24.0	101.6	315.5	97.5	0.277	. . . .	. . . .	. . .	
243	1854 III Je. 22.0	74.6	347.7	108.7	0.648	. . . .	. . . .	. . .	Klinkerfues.
244	1854 IV O. 27.5	129.9	324.5	40.9	0.799	119.6	1309.	0.993	Klinkerfues.
245	1854 V D. 15.7	287.0	238.1	14.2	1.358	99.6	994.2	0.986	Winnecke, Dien.
246	1855 I F. 5.1	323.1	189.7	128.6	2.194	63.	500.	0.965	Schweizer.
247	1855 II My. 30.2	22.6	260.3	156.9	0.567	. . . .	. . . .	. . .	Donati.
248 E.	1855 III Jl. 1.2	183.4	334.4	13.1	0.337	2.215	3.295	0.848	
249	1855 IV N. 25.4	325.5	51.6	169.8	1.231	. . . .	. . . .	. . .	Bruhns.
250	1857 I Mr. 21.4	121.6	313.2	87.9	0.772	. . . .	. . . .	. . .	d'Arrest.
251 Br.	1857 II Mr. 29.3	14.0	101.8	29.8	0.621	3.130	5.538	0.802	Bruhns.
252	1857 III Jl. 18.0	134.1	23.7	121.0	0.367	. . . .	. . . .	. . .	Klinkerfues.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	T			ω	☊	i	q	a	U	e	DISCOVERER.
253	1857	IV	Ag. 24.0	181.0	200.8	32.8	0.747	38.05	235.	0.980	Peters.
254	1857	V	S. 30.9	124.8	15.0	123.9	0.563	182.	2463.	0.997	Klinkerfues.
255	1857	VI	N. 19.1	95.1	139.3	142.2	1.009	335.	6143.	0.997	Donati, van Arsdale.
256 d'A.	1857	VII	N. 28.2	174.6	148.5	13.9	1.170	3.440	6.380	0.660	
257 Tu.	1858	I	F. 23.5	206.8	269.1	54.4	1.025	5.736	13.74	0.821	Tuttle.
258 W.	1858	II	My. 2.0	162.1	113.5	10.8	0.769	3.137	5.555	0.755	Winnecke.
259	1858	III	My. 3.0	25.7	175.1	19.5	1.149	3.523	6.609	0.674	Tuttle.
260	1858	IV	Je. 5.3	98.9	325.0	100.0	0.544	. . . .	. . . .	. . .	Bruhns.
261 F.	1858	V	S. 12.9	200.2	209.7	11.4	1.694	3.813	7.445	0.556	
262	1858	VI	S. 30.0	129.1	165.3	117.0	0.578	152.3	1880.	0.996	Donati.
263	1858	VII	O. 12.8	155.6	159.8	158.7	1.427	330.	6000.	0.996	Tuttle.
264 E.	1858	VIII	O. 18.4	183.5	334.5	13.1	0.341	2.218	3.304	0.846	
265	1859		My. 29.2	282.0	357.3	95.5	0.201	. . . .	. . . .	. . .	Tempel.
266*	1860	I	F. 16.7	209.7	324.1	79.6	1.197	. . . .	. . . .	. . .	Liais.
267	1860	II	Mr. 5.6	41.2	8.9	48.2	1.307	. . . .	. . . .	. . .	Rümker.
268	1860	III	Je. 16.1	76.9	84.7	79.3	0.293	. . . .	. . . .	. . .	
269	1860	IV	S. 22.3	312.0	44.9	32.2	0.683	. . . .	. . . .	. . .	Tempel.
270	1861	I	Je. 3.4	213.4	29.9	79.8	0.921	55.68	415.	0.983	Thatcher.
271	1861	II	Je. 11.5	330.1	279.0	85.4	0.822	55.1	409.1	0.985	Tebbutt.
272	1861	III	D. 7.2	331.6	145.1	138.0	0.839	. . . .	. . . .	. . .	Tuttle.
273 E.	1862	I	F. 6.3	183.5	334.5	13.1	0.340	2.217	3.302	0.847	
274	1862	II	Je. 22.0	27.2	326.6	172.1	0.981	. . . .	. . . .	. . .	Schmidt, Tempel.
275	1862	III	Ag. 22.9	152.8	137.5	113.6	0.963	24.28	119.6	0.960	Tuttle.
276	1862	IV	D. 28.2	230.6	355.8	137.5	0.803	. . . .	. . . .	. . .	Respighi.
277	1863	I	F. 3.5	74.5	116.9	85.4	0.795	. . . .	. . . .	. . .	Bruhns.
278	1863	II	Ap. 4.9	4.9	251.3	112.6	1.068	. . . .	. . . .	. . .	Klinkerfues.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	T	ω	☊	i	q	a	U	e	Discoverer.
279	1863 III Ap. 20.9	55.6	250.2	85.5	0.629	. . . .	. . . .	. . .	Respighi.
280	1863 IV N. 9.5	357.2	97.5	78.1	0.707	. . . .	. . . .	. . .	Tempel.
281	1863 V D. 27.8	115.7	304.7	64.5	0.772	. . . .	. . . .	. . .	Respighi.
282	1863 VI D. 29.2	78.1	105.0	83.3	1.313	. . . .	. . . .	. . .	Bäker.
283	1864 I Jl. 27.8	346.1	175.0	135.0	0.626	. . . .	. . . .	. . .	Donati.
284	1864 II Ag. 15.6	151.0	95.2	178.1	0.909	249.	3934.	0.996	Tempel.
285	1864 III O. 11.4	232.5	31.8	109.7	0.931	. . . .	. . . .	. . .	Donati, Toussaint.
286	1864 IV D. 22.5	118.5	203.2	48.9	0.771	. . . .	. . . .	. . .	Bäker.
287	1864 V D. 27.7	178.5	340.9	162.9	1.115	. . . .	. . . .	. . .	Bruhns.
288	1865 I Ja. 14.3	111.7	252.9	92.5	0.026	. . . .	. . . .	. . .	Abbott.
289 E.	1865 II My. 27.9	183.5	334.5	13.1	0.341	2.218	3.304	0.846	
290	1866 I Ja. 11.1	171.0	231.4	162.7	0.977	10.32	33.18	0.905	Tempel.
291 F.	1866 II F. 14.0	200.2	209.7	11.4	1.682	3.802	7.413	0.558	
292	1867 I Ja. 20.2	357.5	78.5	18.2	1.577	11.71	40.09	0.865	Stephan.
293 T_1	1867 II My. 23.9	135.0	101.2	6.4	1.563	3.189	5.695	0.510	Tempel.
294	1867 III N. 7.0	148.6	65.0	96.6	0.330	. . . .	. . . .	. . .	Bäker.
295 Br.	1868 I Ap. 17.4	14.8	101.2	29.4	0.597	3.109	5.482	0.808	
296	1868 II Je. 26.5	126.6	52.3	131.5	0.579	. . . .	. . . .	. . .	Winnecke.
297 E.	1868 III S. 14.6	183.7	334.5	13.1	0.334	2.212	3.289	0.849	
298 W.	1869 I Je. 29.9	162.4	113.6	10.8	0.781	3.150	5.592	0.752	
299	1869 II O. 9.9	188.2	311.5	111.7	1.231	. . . .	. . . .	. . .	Tempel.
300 T_3-S.	1869 III N. 18.8	106.2	296.8	5.4	1.063	3.109	5.483	0.658	Tempel, Swift.
301	1870 I Jl. 14.1	198.2	141.7	121.8	1.009	. . . .	. . . .	. . .	Winnecke, Tempel.
302	1870 II S. 2.2	354.9	12.9	99.3	1.817	. . . .	. . . .	. . .	Coggia.
303 d'A.	1870 III S. 22.7	172.3	146.4	15.7	1.280	3.507	6.57	0.635	

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	T	ω	☊	i	q	a	U	e	Discoverer.
304	1870 IV D. 19.9	90.6	94.7	147.3	0.389	. . . .	. . . .	. . .	Winnecke.
305	1871 I Je. 10.6	222.5	279.3	87.6	0.654	299.	5178.	0.998	Winnecke, Borelly, Swift.
306	1871 II Jl. 27.0	96.3	211.9	102.0	1.083	. . . .	. . . .	. . .	Tempel.
307 Tu.	1871 III D. 1.8	206.8	269.3	54.3	1.030	5.757	13.811	0.821	
308	1871 IV D. 20.4	242.9	147.1	98.3	0.691	193.5	2691.	0.996	Tempel.
309 E.	1871 V D. 28.8	183.6	334.6	13.1	0.333	2.210	3.285	0.849	
310 T_1	1873 I My. 9.8	159.3	78.7	9.8	1.771	3.296	5.984	0.463	
311 T_2	1873 II Je. 25.2	185.2	120.9	12.8	1.344	3.004	5.207	0.553	Tempel.
312 F.	1873 III Jl. 18.5	200.4	209.6	11.4	1.683	3.801	7.412	0.557	
313	1873 IV S. 10.8	193.8	230.6	96.0	0.794	225.	3375.	0.996	Borelly.
314	1873 V O. 1.8	233.8	176.7	121.5	0.385	. . . .	. . . .	. . .	Henry.
315 Br.	1873 VI O. 10.5	14.8	101.2	29.4	0.594	3.106	5.475	0.809	
316	1873 VII D. 1.4	195.6	250.5	29.9	0.733	. . . .	. . . .	. . .	Coggia, Winnecke.
317	1874 I Mr. 9.9	269.5	30.3	58.9	0.045	. . . .	. . . .	. . .	Winnecke.
318	1874 II Mr. 13.9	331.7	274.1	148.4	0.886	. . . .	. . . .	. . .	Winnecke, Borrelly.
319	1874 III Jl. 8.9	152.4	118.7	66.4	0.676	573.	13708.	0.999	Coggia.
320	1874 IV Jl. 17.7	149.6	215.9	34.1	1.688	45.4	306.0	0.963	Coggia.
321	1874 V Ag. 26.9	92.6	251.5	41.8	0.983	841.	24368.	0.999	Borelly.
322	1874 VI O. 18.9	16.3	282.0	99.2	0.508	. . . .	. . . .	. . .	Borelly.
323 W.	1875 I Mr. 12.1	165.1	111.6	11.3	0.829	3.201	5.726	0.741	
324 E.	1875 II Ap. 13.0	183.7	334.6	13.1	0.333	2.211	3.287	0.849	
325	1877 I Ja. 19.2	347.2	187.3	153.0	0.807	. . . .	. . . .	. . .	Borelly, Pechüle.
326	1877 II Ap. 17.7	63.1	316.6	121.1	0.950	. . . .	. . . .	. . .	Winnecke, Block.
327	1877 III Ap. 26.8	116.8	346.1	77.2	1.009	486.	10718.	0.998	Swift, Block, Borelly.
328 d'A.	1877 IV My. 10.5	173.0	146.2	15.7	1.318	3.541	6.664	0.628	
329	1877 V Je. 27.1	103.2	184.3	115.7	1.070	. . . .	. . . .	. . .	Tempel.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	T			ω	☊	i	q	a	U	e	DISCOVERER.
330	1877	VI	S. 11.2	143.2	251.0	102.2	1.576	. . . .	. . . .	. . .	Coggia.
331	1878	I	Jl. 20.7	177.6	102.3	78.2	1.392	. . . .	. . . .	. . .	Swift.
332 E.	1878	II	Jl. 26.2	183.7	334.7	13.1	0.333	2.212	3.285	0.849	
333 T_2	1878	III	S. 7.3	185.1	121.0	12.8	1.340	3.001	5.202	0.554	
334 Br.	1879	I	Mr. 30.5	14.9	101.3	29.4	0.590	3.101	5.470	0.810	
335	1879	II	Ap. 27.4	3.7	45.8	107.0	0.897	. . . .	. . . .	. . .	Swift.
336 T_1	1879	III	My. 7.1	159.5	78.8	9.8	1.771	3.295	5.982	0.463	
337	1879	IV	Ag. 29.3	84.3	32.4	107.8	0.991	. . . .	. . . .	. . .	Hartwig.
338	1879	V	O. 4.6	115.4	87.2	77.1	0.990	. . . .	. . . .	. . .	Palisa.
339	1880	I	Ja. 27.6	86.3	6.2	144.7	0.005	. . . .	. . . .	. . .	Gould.
340	1880	II	Jl. 1.7	145.2	257.3	123.1	1.814	. . . .	. . . .	. . .	Schaeberle.
341	1880	III	S. 6.9	323.1	45.3	141.9	0.355	. . . .	. . . .	. . .	Hartwig.
342 T_3-S.	1880	IV	N. 8.0	106.2	296.9	5.4	1.067	3.113	5.493	0.657	Swift.
343	1880	V	N. 9.4	11.7	249.4	60.7	0.660	. . . .	. . . .	. . .	Pechüle.
344 F.	1881	I	Ja. 22.7	201.2	209.6	11.3	1.738	3.854	7.566	0.549	
345	1881	II	My. 20.4	173.8	126.4	78.0	0.591	. . . .	. . . .	. . .	Swift.
346	1881	III	Je. 16.4	354.3	271.0	63.4	0.734	206.	2954.	0.996	Tebbutt.
347	1881	IV	Ag. 22.3	122.1	97.0	140.2	0.634	. . . .	. . . .	. . .	Schaeberle.
348	1881	V	S. 13.3	312.5	65.9	6.9	0.725	4.226	8.687	0.828	Denning.
349	1881	VI	S. 14.4	6.3	274.2	112.8	0.449	. . . .	. . . .	. . .	Barnard.
350 E.	1881	VII	N. 15.3	183.9	334.6	12.9	0.343	2.221	3.310	0.845	
351	1881	VIII	N. 19.8	118.0	181.4	144.8	1.923	72.1	612.3	0.973	Swift.
352	1882	I	Je. 10.5	209.0	204.9	73.8	0.061	. . . .	. . . .	0.999+	Wells.
353	1882	II	S. 17.2	69.6	346.0	142.0	0.008	84.	772.	0.999+	
354	1882	III	N. 13.0	254.3	249.1	96.2	0.955	1239.	43601.	0.999	Barnard.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	T	ω	☊	i	q	a	U	e	Discoverer.
355	1883 I F. 18.9	110.9	278.1	78.1	0.760	831.	23946.	0.999+	Brooks.
356	1883 II D. 25.3	138.7	264.4	115.0	0.310	. . . .	. . . .	. . .	Ross.
357 P-Bs.	1884 I Ja. 25.7	199.2	254.1	74.0	0.776	17.2	71.56	0.955	Brooks.
358	1884 II Ag. 16.5	301.0	5.1	5.5	1.279	3.078	5.400	0.584	Barnard.
359 Wo.	1884 III N. 17.8	172.7	206.3	25.3	1.571	3.580	6.774	0.561	Wolf.
360 E.	1885 I Mr. 7.6	183.9	334.6	12.9	0.342	2.220	3.307	0.846	
361	1885 II Ag. 5.7	178.5	92.3	80.6	2.507	. . . .	. . . .	. . .	Barnard.
362	1885 III Ag. 10.4	43.4	204.5	59.3	0.755	. . . .	. . . .	. . .	Brooks.
363 Tu.	1885 IV S. 11.1	206.8	269.7	54.3	1.024	5.742	13.76	0.822	
364	1885 V N. 25.5	35.6	262.2	42.4	1.080	. . . .	. . . .	. . .	Brooks.
365	1886 I Ap. 6.0	126.6	36.4	82.6	0.642	. . . .	. . . .	. . .	Fabry.
366	1886 II My. 3.3	119.6	68.3	84.4	0.479	. . . .	. . . .	1.0002	Barnard.
367	1886 III My. 4.5	38.6	287.8	100.2	0.842	. . . .	. . . .	. . .	Brooks.
368	1886 IV Je. 6.7	176.8	53.5	12.7	1.327	3.152	5.595	0.579	Brooks.
369	1886 V Je. 7.4	201.2	192.7	87.7	0.270	. . . .	. . . .	. . .	Brooks.
370 W.	1886 VI S. 4.4	172.0	104.1	14.5	0.885	3.234	5.816	0.726	
371 Fi.	1886 VII N. 22.4	315.1	52.5	3.0	0.998	3.536	6.648	0.718	Finlay.
372	1886 VIII N. 28.4	31.9	258.2	85.6	1.480	. . . .	. . . .	. . .	Barnard.
373	1886 IX D. 16.5	86.3	137.4	101.6	0.663	. . . .	. . . .	. . .	Barnard.
374	1887 I Ja. 11.3	65.4	339.6	137.6	0.005	. . . .	. . . .	. . .	Thome.
375	1887 II Mr. 17.4	159.4	279.9	104.3	1.630	106.	1090.	0.984	Brooks.
376	1887 III Mr. 28.4	36.5	135.5	139.8	1.007	. . . .	. . . .	1.0004	Barnard.
377	1887 IV Je. 16.7	15.1	245.2	17.6	1.394	356.	6725.	0.996	Barnard.
378 O.	1887 V O. 8.5	65.3	84.5	44.6	1.199	17.41	72.65	0.931	
379	1888 I Mr. 17.0	359.9	245.4	42.3	0.699	168.	2182.	0.996	Sawerthal.
380 F.	1888 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	*T*		ω	☊	i	q	a	U	e	DISCOVERER.
381	1888 III	Jl. 31.1	59.2	101.5	74.2	0.902	. . . .	. . . .	. . .	Brooks.
382 F.	1888 IV	Ag. 19.9	201.2	209.6	11.3	1.738	3.854	7.566	0.549	
383	1888 V	S. 13.0	291.1	137.6	56.4	1.533	. . . .	. . . .	. . .	Barnard.
384	1889 I	Ja. 31.2	340.5	357.4	166.4	1.814	. . . .	. . . .	. . .	Barnard.
385	1889 II	Je. 10.8	236.1	310.7	163.8	2.255	. . . .	. . . .	. . .	Barnard.
386	1889 III	Je. 20.8	60.1	271.0	31.2	1.103	25.5	128.3	0.957	Barnard.
387	1889 IV	Jl. 19.3	345.9	286.2	66.0	1.040	298.	5127.	0.996	Davidson.
388	1889 V	S. 30.3	343.6	18.0	6.1	1.950	3.684	7.072	0.471	Brooks.
389	1889 VI	N. 29.5	69.7	330.6	10.2	1.354	4.176	8.534	0.676	Swift.
390	1890 I	Ja. 26.5	199.9	8.4	56.7	0.270	. . . .	. . . .	. . .	Borelly.
391	1890 II	Je. 1.5	68.9	320.3	120.6	1.907	. . . .	. . . .	. . .	Brooks.
392	1890 III	Jl. 8.5	85.7	14.3	63.3	0.764	. . . .	. . . .	. . .	Coggia.
393	1890 IV	Ag. 7.2	331.4	85.4	154.3	2.047	. . . .	. . . .	. . .	Zona.
394 d'A.	1890 V	S. 17.5	173.0	146.3	15.7	1.324	3.551	6.691	0.627	
395	1890 VI	S. 24.5	163.0	100.1	98.9	1.260	. . . .	. . . .	. . .	Denning.
396	1890 VII	O. 26.1	13.1	45.1	12.9	1.818	3.448	6.402	0.473	Spitaler.
397	1891 I	Ap. 27.5	178.9	193.9	120.5	0.397	. . . .	. . . .	. . .	Barnard.
398 Wo.	1891 II	S. 3.4	172.8	206.4	25.2	1.593	3.597	6.821	0.557	
399 E.	1891 III	O. 18.0	184.0	334.7	12.9	0.340	2.218	3.303	0.846	
400	1891 IV	N. 12.9	268.6	217.6	77.7	0.977	. . . .	. . . .	. . .	Barnard.
401 Ts-S.	1891 V	N. 15.0	106.7	296.5	5.4	1.087	3.129	5.534	0.653	
402	1892 I	Ap. 6.7	24.5	240.9	38.7	1.027	740.	20143.	0.999	Swift.
403	1892 II	My. 11.2	129.3	253.4	89.7	1.971	. . . .	. . . .	. . .	Denning.
404	1892 III	Je. 13.2	14.2	331.7	20.8	2.139	3.626	6.904	0.410	Holmes.
405 W.	1892 IV	Je. 30.9	172.1	104.1	14.5	0.887	3.235	5.818	0.726	
406	1892 V	D. 11.1	170.3	206.7	31.2	1.428	3.384	6.226	0.578	Barnard.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	T			ω	☊	i	q	a	U	e	DISCOVERER.
153	1818	I	F. 3.2	180.3	256.0	34.2	0.696	....	....	...	Pons.
154	1818	II	F. 26.0	112.3	70.4	89.7	1.198	....	....	...	Pons.
155	1818	III	D. 5.0	348.2	90.0	117.0	0.855	....	....	1.012	Pons.
156 E.	1819	I	Ja. 28.0	182.4	334.6	13.6	0.335	2.214	3.295	0.849	Pons.
157	1819	II	Je. 27.7	13.4	273.7	80.7	0.341	....	....	...	Tralles.
158 W.	1819	III	Jl. 18.9	161.5	113.2	10.7	0.774	3.160	5.618	0.755	Pons.
159	1819	IV	N. 20.3	350.1	77.2	9.0	0.893	2.849	4.810	0.687	Blanpain, Pons.
160	1821		Mr. 21.5	169.2	48.7	106.4	0.092	....	....	...	Nicollet, Pons.
161	1822	I	My. 5.6	344.7	177.4	126.4	0.504	....	....	...	Gambart.
162 E.	1822	II	My. 24.0	182.8	334.4	13.3	0.346	2.224	3.318	0.845	
163	1822	III	Jl. 15.9	237.7	97.7	143.7	0.847	....	....	...	Pons.
164	1822	IV	O. 23.8	181.1	92.7	127.3	1.145	309.7	5449.	0.996	Pons.
165	1823		D. 9.5	28.5	303.1	103.8	0.227	....	....	...	Köhler.
166	1824	I	Jl. 11.5	334.0	234.3	125.4	0.591	....	....	...	Rümker.
167	1824	II	S. 29.1	85.3	279.3	54.6	1.050	....	....	...	Scheithauer.
168	1825	I	My. 30.6	106.2	20.1	123.3	0.889	....	....	...	Gambart.
169	1825	II	Ag. 18.7	177.3	192.9	89.7	0.883	....	....	...	Pons.
170 E.	1825	III	S. 16.3	182.8	334.5	13.4	0.345	2.233	3.315	0.845	
171	1825	IV	D. 10.7	256.9	215.7	146.5	1.241	271.4	4472.	0.995	Pons.
172 B.	1826	I	Mr. 18.4	218.3	251.5	13.6	0.903	3.561	6.720	0.747	Biela.
173	1826	II	Ap. 21.9	279.4	197.6	40.0	2.008	....	....	...	Pons.
174	1826	III	Ap. 29.0	4.7	40.5	174.7	0.188	....	....	...	Flaugergues.
175	1826	IV	O. 9.0	13.7	44.1	26.0	0.853	....	....	...	Pons.
176	1826	V	N. 18.4	279.6	235.1	90.6	0.027	....	....	...	Pons.
177	1827	I	F. 4.9	151.0	184.5	102.4	0.507	....	....	...	Pons.
178	1827	II	Je. 7.8	20.6	318.2	136.4	0.808	....	....	...	Pons, Gambart.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	T		ω	☊	i	q	a	U	e	Discoverer.
26	1362	Mr. 2.3	10.	237.	148.	0.470	. . . .	. . . .	. . .	
27	1366	O. 21.5	169.4	217.4	152.4	0.980	. . . .	. . . .	. . .	
28 H.	1378	N. 8.8	107.8	47.3	162.1	0.583	. . . .	. . . .	. . .	
29	1385	O. 16.3	166.7	268.5	127.8	0.774	. . . .	. . . .	. . .	
30	1402	Mr. 21.	91.	117.	55.	0.380	. . . .	. . . .	. . .	
31	1433	N. 7.8	189.3	96.3	104.0	0.493	. . . .	. . . .	. . .	
32	1449	D. 9.4	356.9	261.3	155.7	0.327	. . . .	. . . .	. . .	
33 H.	1456	Je. 8.2	104.8	43.8	162.4	0.580	17.97	75.	0.968	
34	1457 I	Ja. 18.0	194.9	249.7	13.3	0.703	. . . .	. . . .	. . .	
35	1457 II	Ag. 8.0	185.1	184.4	9.9	0.760	. . . .	. . . .	. . .	
36	1468	O. 7.4	69.7	71.1	142.0	0.830	. . . .	. . . .	. . .	
37	1472	F. 29.9	246.1	285.9	170.8	0.486	. . . .	. . . .	. . .	Regiomontanus.
38	1490	D. 24.5	129.9	288.8	51.6	0.738	. . . .	. . . .	. . .	
39	1499	S. 6.2	33.5	326.5	21.	0.954	. . . .	. . . .	. . .	
40	1500	My. 17.	20.	310.	105.	1.400	. . . .	. . . .	. . .	
41	1506	S. 3.7	242.2	132.8	135.0	0.386	. . . .	. . . .	. . .	
42 H.	1531	Ag. 25.8	104.3	45.5	163.0	0.580	17.79	75.0	0.967	Apianus.
43	1532	O. 18.3	24.4	87.4	32.6	0.519	. . . .	. . . .	. . .	Fracastor.
44	1533	Je. 14.9	278.4	299.3	28.2	0.327	. . . .	. . . .	. . .	
45	1556	Ap. 22.2	100.9	175.2	32.4	0.491	. . . .	. . . .	. . .	
46	1558	S. 13.6	119.6	335.0	110.9	0.280	. . . .	. . . .	. . .	
47	1577	O. 27.0	255.6	25.3	104.8	0.177	. . . .	. . . .	. . .	Tycho Brahe.
48	1580	N. 28.5	89.3	19.1	64.6	0.602	. . . .	. . . .	. . .	Moestlin.
49	1582	My. 6.4	333.0	229.3	119.2	0.168	. . . .	. . . .	. . .	Tycho Brahe.
		New Style								
50	1585	O. 8.0	331.4	37.7	6.1	1.095	. . . .	. . . .	. . .	William IV v. Hesse.

TABLE I—*(Continued)*. Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	T	ω	☊	i	q	a	U	e	Discoverer.
51	1590 F. 8.0	307.7	165.6	150.5	0.568	. . . .	. . . .	. . .	Tycho Brahe.
52	1593 Jl. 18.6	12.1	164.2	88.0	0.089	. . . .	. . . .	. . .	Ripensis.
53	1596 Jl. 25.2	59 4	330.3	128.0	0.567	. . . .	. . . .	. . .	
54 H.	1607 O. 26.7	107 0	48.7	162.8	0.588	17.87	75.5	0.967	Harriot.
55	1618 I Ag. 17.1	24.9	293.4	21.5	0.513	. . . .	. . . .	. . .	Kepler.
56	1618 II N. 8.4	287.4	75.7	37.2	0.390	. . . .	. . . .	. . .	Kirch.
57	1652 N. 12.7	300.1	88.2	79.5	0.847	. . . .	. . . .	. . .	Hevelius.
58	1661 Ja. 26.9	33.4	81.9	33 0	0.443	. . . .	. . . .	. . .	Hevelius.
59	1664 D. 4.5	310.6	81.3	158.7	1.026	. . . .	. . . .	. . .	
60	1665 Ap. 24.2	156.1	228.0	103.9	0.106	. . . .	. . . .	. . .	Hevelius.
61	1668 F. 28.8	80.3	357.3	144.0	0.005	. . . .	. . . .	. . .	Ægidius.
62	1672 Mr. 1.5	109.6	298.1	82.9	0.695	. . . .	. . .	. . .	
63	1677 My. 6.0	99.2	236.8	100.9	0.281	. . . .	. . . .	. . .	Hevelius.
64	1678 Ag. 18.3	159.5	163.3	2.9	1.145	3 070	5.38	0.627	Lahire.
65	1680 D. 18.0	350.6	272.2	60.7	0.006	426.7	8814.	1.000	Kirch.
66 H.	1682 S. 14.8	109.3	51.2	162.3	0.583	18.17	77.5	0.968	
67	1683 Jl. 13.1	87.8	173.4	96.8	0.560	. . . .	. . . .	. . .	Flamsteed.
68	1684 Je. 8.3	330.3	268.2	65 4	0.958	. . . .	. . . .	. . .	Bianchini.
69	1686 S. 15.8	81.9	354.1	34.9	0.336	. . . .	. . . .	. . .	
70	1689 N. 30.2	78.2	279.4	63.2	0.064	. . . .	. . . .	. . .	Richaud.
71	1695 N. 9.7	204.	216.	22.	0.844	. . . .	. . . .	. . .	Jacob.
72	1698 O. 17.0	151.2	65.9	169.1	0.729	. . . .	. . . .	. . .	Lahire.
73	1699 Ja. 13.4	109.5	321.7	109.4	0.749	. . . .	. . . .	. . .	de Fontenay.
74	1701 O. 17.4	165.0	298.7	138.4	0.593	. . . .	. . . .	. . .	Pallu.
75	1702 Mr. 13.6	309.8	189.0	4.4	0.647	. . . .	. . . .	. . .	Bianchini.
76	1706 Ja. 30.2	59.4	13.2	55.2	0.427	. . . .	. . . .	. . .	Cassini

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	*T*		ω	☊	*i*	*q*	*a*	*U*	*e*	DISCOVERER.
77	1707	D. 12.0	27.1	52.8	88.6	0.860	. . . .	. . . .	. . .	Manfredi.
78	1718	Ja. 14.9	6.3	127.9	148.9	1.025	. . . .	. . . .	. . .	Kirch.
79	1723	S. 27.6	331.4	14.2	130.0	0.999	. . . .	. . . .	. . .	
80	1729	Je. 16.2	10.4	310.6	77.1	4.051	. . . .	. . . .	. . .	Sarabat.
81	1737 I	Ja. 30.4	99.5	226.4	18.3	0.223	. . . .	. . . .	. . .	
82	1737 II	Je. 2.2	129.9	132.1	61.9	0.835	. . . .	. . . .	. . .	
83	1739	Je. 17.4	104.8	207.4	124.3	0.674	. . . .	. . . .	. . .	Zanotti.
84	1742	F. 8.6	328.5	185.2	112.5	0.770	. . . .	. . . .	. . .	Grant.
85	1743 I	Ja. 8.2	6.4	86.9	1.9	0.862	3.10	6.73	0.721	Grischow.
86	1743 II	S. 20.7	119.0	6.0	134.4	0.523	. . . .	. . . .	. . .	Klinkenberg.
87	1744	Mr. 1.3	151.4	45.8	47.1	0.222	. . . .	. . . .	. . .	Klinkenberg.
88	1747	Mr. 3.3	230.3	147.3	100.9	2.199	. . . .	. . . .	. . .	Chéseaux.
89	1748 I	Ap. 28.8	17.5	232.9	94.5	0.840	. . . .	. . . .	. . .	
90	1748 II	Je. 18.9	245.6	33.1	67.1	0.625	. . . .	. . . .	. . .	Klinkenberg.
91	1757	O. 21.4	268.5	214.1	12.7	0.339	. . . .	. . . .	. . .	Bradley.
92	1758	Je. 11.1	36.8	230.8	68.3	0.215	. . . .	. . . .	. . .	de la Nux.
93 H.	1759 I	Mr. 12.6	110.6	53.8	162.4	0.585	18.09	76.9	0.968	Palitzsch.
94	1759 II	N. 27.1	273.7	139.7	79.0	0.799	. . . .	. . . .	. . .	Messier.
95	1759 III	D. 16.8	301.4	79.8	175.1	0.966	. . . .	. . . .	. . .	
96	1762	My. 28.3	115.5	348.6	85.6	1.009	. . . .	. . . .	. . .	Klinkenberg.
97	1763	N. 1.9	88.6	356.4	72.5	0.498	377.	7335.	0.999	Messier.
98	1764	F. 12.6	104.8	120.1	127.1	0.555	. . . .	. . . .	. . .	Messier.
99	1766 I	F. 17.4	100.9	244.2	139.2	0.505	. . . .	. . . .	. . .	Messier.
100	1766 II	Ap. 27.0	177.0	74.2	8.0	0.399	2.934	5.025	0.864	Helfenzrieder.
101	1769	O. 7.6	329.1	175.1	40.8	0.123	163.5	2090.	0.999	Messier.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	T	ω	☊	i	q	a	U	e	Discoverer.
253	1857 IV Ag. 24.0	181.0	200.8	32.8	0.747	38.05	235.	0.980	Peters.
254	1857 V S. 30.9	124.8	15.0	123.9	0.563	182.	2463.	0.997	Klinkerfues.
255	1857 VI N. 19.1	95.1	139.3	142.2	1.009	335.	6143.	0.997	Donati, van Arsdale.
256 d'A.	1857 VII N. 28.2	174.6	148.5	13.9	1.170	3.440	6.380	0.660	
257 Tu.	1858 I F. 23.5	206.8	269.1	54.4	1.025	5.736	13.74	0.821	Tuttle.
258 W.	1858 II My. 2.0	162.1	113.5	10.8	0.769	3.137	5.555	0.755	Winnecke.
259	1858 III My. 3.0	25.7	175.1	19.5	1.149	3.523	6.609	0.674	Tuttle.
260	1858 IV Je. 5.3	98.9	325.0	100.0	0.544	. . . .	. . . .	. . .	Bruhns.
261 F.	1858 V S. 12.9	200.2	209.7	11.4	1.694	3.813	7.445	0.556	
262	1858 VI S. 30.0	129.1	165.3	117.0	0.578	152.3	1880.	0.996	Donati.
263	1858 VII O. 12.8	155.6	159.8	158.7	1.427	330.	6000.	0.996	Tuttle.
264 E.	1858 VIII O. 18.4	183.5	334.5	13.1	0.341	2.218	3.304	0.846	
265	1859 My. 29.2	282.0	357.3	95.5	0.201	. . . .	. . . .	. . .	Tempel.
266*	1860 I F. 16.7	209.7	324.1	79.6	1.197	. . . .	. . . .	. . .	Liais.
267	1860 II Mr. 5.6	41.2	8.9	48.2	1.307	. . . .	. . . .	. . .	Rümker.
268	1860 III Je. 16.1	76.9	84.7	79.3	0.293	. . . .	. . . .	. . .	
269	1860 IV S. 22.3	312.0	44.9	32.2	0.683	. . . .	. . . .	. . .	Tempel.
270	1861 I Je. 3.4	213.4	29.9	79.8	0.921	55.68	415.	0.983	Thatcher.
271	1861 II Je. 11.5	330.1	279.0	85.4	0.822	55.1	409.1	0.985	Tebbutt.
272	1861 III D. 7.2	331.6	145.1	138.0	0.839	. . . .	. . . .	. . .	Tuttle.
273 E.	1862 I F. 6.3	183.5	334.5	13.1	0.340	2.217	3.302	0.847	
274	1862 II Je. 22.0	27.2	326.6	172.1	0.981	. . . .	. . . .	. . .	Schmidt, Tempel.
275	1862 III Ag. 22.9	152.8	137.5	113.6	0.963	24.28	119.6	0.960	Tuttle.
276	1862 IV D. 28.2	230.6	355.8	137.5	0.803	. . . .	. . . .	. . .	Respighi.
277	1863 I F. 3.5	74.5	116.9	85.4	0.795	. . . .	. . . .	. . .	Bruhns.
278	1863 II Ap. 4.9	4.0	251.3	112.6	1.068	. . . .	. . . .	. . .	Klinkerfues.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	T		ω	☊	i	q	a	U	e	DISCOVERER.
128	1793 II	N. 19.5	69.3	2.3	51.9	1.504	. . . .	. . . .	. . .	Perny.
129 E	1795	D. 21.4	182.0	334.7	13.7	0.334	2.213	3.292	0.849	C. Herschel.
130	1796	Ap. 2.8	184.3	17.0	115.1	1.578	. . . .	. . . .	. . .	Olbers.
131	1797	Jl. 9.1	279.8	329.3	129.3	0.527	. . . .	. . . .	. . .	Bouvard, C. Herschel, Lee.
132	1798 I	Ap. 4.5	342.9	122.2	43.7	0.485	. . . .	. . . .	. . .	Messier.
133	1798 II	D. 31.5	215.0	249.5	137.6	0.780	. . . .	. . . .	. . .	Bouvard.
134	1799 I	S. 7.2	95.8	99.5	129.1	0.840	. . . .	. . . .	. . .	Méchain.
135	1799 II	D. 25.9	136.5	326.8	103.0	0.626	. . . .	. . . .	. . .	Méchain.
136	1801	Ag. 8.6	219.8	42.5	159.2	0.256	. . . .	. . . .	. . .	Pons, Messier.
137	1802	S. 9.9	21.9	310.3	57.0	1.094	. . . .	. . . .	. . .	Pons.
138	1804	F. 13.6	331.9	176.8	56.5	1.071	. . . .	. . . .	. . .	Pons.
139 E.	1805	N. 21.5	182.5	334.3	13.6	0.340	2.213	3.292	0.846	Bouvard, Pons, Huth.
140 B.	1806 I	Ja. 2.0	218.2	251.3	13.6	0.907	3.567	6.737	0.746	Pons.
141	1806 II	D. 28.9	225.3	322.4	145.0	1.082	. . . .	. . . .	1.010	Pons.
142	1807	S. 18.7	4.1	266.8	63.2	0.646	143.2	1714.	0.995	Parisi.
143	1808 I	My. 13.0	253.8	323.0	134.3	0.390	. . . .	. . . .	. . .	Pons.
144	1808 II	Jl. 12.2	131.5	24.2	140.7	0.608	. . . .	. . . .	. . .	Pons.
145	1810	O. 6.2	114.9	308.8	62.9	0.970	. . . .	. . . .	. . .	Pons.
146	1811 I	S. 12.3	65.4	140.4	107.0	1.035	212.3	3094.	0.995	Flaugergues.
147	1811 II	N. 11.0	314.4	93.0	31.3	1.582	91.51	875.	0.983	Pons.
148	1812	S. 15.3	199.3	253.0	74.0	0.777	17.5	73.	0.956	Pons.
149	1813 I	Mr. 4.5	350.9	60.8	158.8	0.699	. . . .	. . . .	. . .	Pons.
150	1813 II	My. 19.5	205.1	42.7	98.9	1.215	. . . .	. . . .	. . .	Pons.
151 O.	1815	Ap. 26.0	65.6	83.5	44.5	1.213	17.63	74.	0.931	Olbers.
152	1816	Mr. 1.4	304.3	323.2	43.1	0.049	. . . .	. . . .	. . .	Pons.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	T	ω	☊	i	q	a	U	e	DISCOVERER.
304	1870 IV D. 19.9	90.6	94.7	147.3	0.389	. . . .	. . . .	. . .	Winnecke.
305	1871 I Je. 10.6	222.5	279.3	87.6	0.654	299.	5178.	0.998	Winnecke, Borelly, Swift.
306	1871 II Jl. 27.0	96.3	211.9	102.0	1.083	. . . .	. . . .	. . .	Tempel.
307 Tu.	1871 III D. 1.8	206.8	269.3	54.3	1.030	5.757	13.811	0.821	
308	1871 IV D. 20.4	242.9	147.1	98.3	0.691	193.5	2691.	0.996	Tempel.
309 E.	1871 V D. 28.8	183.6	334.6	13.1	0.333	2.210	3.285	0.849	
310 T_1	1873 I My. 9.8	159.3	78.7	9.8	1.771	3.296	5.984	0.463	
311 T_2	1873 II Je. 25.2	185.2	120.9	12.8	1.344	3.004	5.207	0.553	Tempel.
312 F.	1873 III Jl. 18.5	200.4	209.6	11.4	1.683	3.801	7.412	0.557	
313	1873 IV S. 10.8	193.8	230.6	96.0	0.794	225.	3375.	0.996	Borelly.
314	1873 V O. 1.8	233.8	176.7	121.5	0.385	. . . .	. . . .	. . .	Henry.
315 Br.	1873 VI O. 10.5	14.8	101.2	29.4	0.594	3.106	5.475	0.809	
316	1873 VII D. 1.4	195.6	250.5	29.9	0.733	. . . .	. . . .	. . .	Coggia, Winnecke.
317	1874 I Mr. 9.9	269.5	30.3	58.9	0.045	. . . .	. . . .	. . .	Winnecke.
318	1874 II Mr. 13.9	331.7	274.1	148.4	0.886	. . . .	. . . .	. . .	Winnecke, Borrelly.
319	1874 III Jl. 8.9	152.4	118.7	66.4	0.676	573.	13708.	0.999	Coggia.
320	1874 IV Jl. 17.7	149.6	215.9	34.1	1.688	45.4	306.0	0.963	Coggia.
321	1874 V Ag. 26.9	92.6	251.5	41.8	0.983	841.	24368.	0.999	Borelly.
322	1874 VI O. 18.9	16.3	282.0	99.2	0.508	. . . .	. . . .	. . .	Borelly.
323 W.	1875 I Mr. 12.1	165.1	111.6	11.3	0.829	3.201	5.726	0.741	
324 E.	1875 II Ap. 13.0	183.7	334.6	13.1	0.333	2.211	3.287	0.849	
325	1877 I Ja. 19.2	347.2	187.3	153.0	0.807	. . . .	. . . .	. . .	Borelly, Pechüle.
326	1877 II Ap. 17.7	63.1	316.6	121.1	0.950	. . . .	. . . .	. . .	Winnecke, Block.
327	1877 III Ap. 26.8	116.8	346.1	77.2	1.009	486.	10718.	0.998	Swift, Block, Borelly.
328 d'A.	1877 IV My. 10.5	173.0	146.2	15.7	1.318	3.541	6.664	0.628	
329	1877 V Je. 27.1	103.2	184.3	115.7	1.070	. . . .	. . . .	. . .	Tempel.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	*T*			ω	☊	*i*	*q*	*a*	*U*	*e*	DISCOVERER.
179	1827	III	S. 11.7	258.7	149.7	125.9	0.138	189.6	2611.	0.999	Pons.
180 E.	1829		Ja. 9.7	182.8	334.5	13.3	0.346	2.224	3.316	0.845	
181	1830	I	Ap. 9.3	5.8	206.4	21.3	0.921	. . . .	. . . .	. . .	d'Abbadie.
182	1830	II	D. 27.7	26.9	337 9	135.2	0.126	. . . .	. . . .	. . .	Herapath.
183 E.	1832	I	My. 4.0	182.8	334.5	13.4	0.343	2.222	3.312	0.845	
184	1832	II	S. 25 6	204.6	72.5	136.7	1.183	. . . .	. . . .	. . .	Gambart.
185 B.	1832	III	N. 26.1	221.8	248.3	13.2	0.879	3.537	6.652	0.751	
186	1833		S. 10.4	260.9	323.5	7.3	0.464	. . . .	. . . .	. . .	Dunlop.
187	1834		Ap. 2.8	50.2	226.6	6.0	0.513	. . . .	. . . .	. . .	Gambart.
188	1835	I	Mr. 27.6	210.6	58.3	170.9	2.041	. . . .	. . . .	. . .	Boguslawski.
189 E.	1835	II	Ag. 26.4	182.8	334.6	13.4	0.344	2.223	3.314	0.845	
190 H.	1835	III	N. 15.9	110.6	55.2	162.2	0.587	17.99	76.29	0.967	
191 E.	1838		D. 19.0	182.8	334.6	13.4	0.344	2.222	3.313	0.845	
192	1840	I	Ja. 4.5	72.2	120.0	53.1	0.618	. . . .	. . . .	0.999+	Galle.
193	1840	II	Mr. 13.1	156 6	236.8	120.8	1.221	243.	3789.	0 995	Galle.
194	1840	III	Ap. 2.4	138.0	186 0	79.9	0.748	. . . .	. . . .	. . .	Galle.
195	1840	IV	N. 13.7	133.6	248.9	58.0	1.481	51.3	367.2	0.971	Bremiker.
196 E.	1842	I	Ap. 12.0	182.8	334.7	13.3	0.345	2.223	3.314	0.845	
197	1842	II	D. 16.0	240.5	207.8	106.4	0.504	. . . .	. . . .	. . .	Laugier.
198	1843	I	F. 27.4	82.6	1.3	144.3	0.006	64.03	512.	0.999+	
199	1843	II	My. 6.1	124 2	157.2	52.7	1.615	. . . .	. . . .	. . .	Mauvais.
200 F.	1843	III	O. 17.1	200.1	209.5	11.4	1.693	3.812	7.442	0.556	Faye.
201	1844	I	S. 2.5	278.7	63.8	2.9	1.186	3.100	5.459	0.617	de Vico.
202	1844	II	O. 17.4	211.3	31.7	131.4	0.855	. . . .	. . . .	. . .	Mauvais.
203	1844	III	D. 13.7	177.7	118.3	45.6	0.252	. . . .	. . . .	1.000+	

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	T	ω	☊	i	q	a	U	e	DISCOVERER.
355	1883 I F. 18.9	110.9	278.1	78.1	0.760	831.	23946.	0.999+	Brooks.
356	1883 II D. 25.3	138.7	264.4	115.0	0.310	. . . .	. . . .	. . .	Ross.
357 P-Bs.	1884 I Ja. 25.7	199.2	254.1	74.0	0.776	17.2	71.56	0.955	Brooks.
358	1884 II Ag. 16.5	301.0	5.1	5.5	1.279	3.078	5.400	0.584	Barnard.
359 Wo.	1884 III N. 17.8	172.7	206.3	25.3	1.571	3.580	6.774	0.561	Wolf.
360 E.	1885 I Mr. 7.6	183.9	334.6	12.9	0.342	2.220	3.307	0.846	
361	1885 II Ag. 5.7	178.5	92.3	80.6	2.507	. . . .	. . . .	. . .	Barnard.
362	1885 III Ag. 10.4	43.4	204.5	59.3	0.755	. . . .	. . . .	. . .	Brooks.
363 Tu.	1885 IV S. 11.1	206.8	269.7	54.3	1.024	5.742	13.76	0.822	
364	1885 V N. 25.5	35.6	262.2	42.4	1.080	. . . .	. . . .	. . .	Brooks.
365	1886 I Ap. 6.0	126.6	36.4	82.6	0.642	. . . .	. . . .	. . .	Fabry.
366	1886 II My. 3.3	119.6	68.3	84.4	0.479	. . . .	. . . .	1.0002	Barnard.
367	1886 III My. 4.5	38.6	287.8	100.2	0.842	. . . .	. . . .	. . .	Brooks.
368	1886 IV Je. 6.7	176.8	53.5	12.7	1.327	3.152	5.595	0.579	Brooks.
369	1886 V Je. 7.4	201.2	192.7	87.7	0.270	. . . .	. . . .	. . .	Brooks.
370 W.	1886 VI S. 4.4	172.0	104.1	14.5	0.885	3.234	5.816	0.726	
371 Fi.	1886 VII N. 22.4	315.1	52.5	3.0	0.998	3.536	6.648	0.718	Finlay.
372	1886 VIII N. 28.4	31.9	258.2	85.6	1.480	. . . .	. . . .	. . .	Barnard.
373	1886 IX D. 16.5	86.3	137.4	101.6	0.663	. . . .	. . . .	. . .	Barnard.
374	1887 I Ja. 11.3	65.4	339.6	137.6	0.005	. . . .	. . . .	. . .	Thome.
375	1887 II Mr. 17.4	159.4	279.9	104.3	1.630	106.	1090.	0.984	Brooks.
376	1887 III Mr. 28.4	36.5	135.5	139.8	1.007	. . . .	. . . .	1.0004	Barnard.
377	1887 IV Je. 16.7	15.1	245.2	17.6	1.394	356.	6725.	0.996	Barnard.
378 O.	1887 V O. 8.5	65.3	84.5	44.6	1.199	17.41	72.65	0.931	
379	1888 I Mr. 17.0	359.9	245.4	42.3	0.699	168.	2182.	0.996	Sawerthal.
380 E.	1888 II Je. 28.0	184.0	334.6	12.9	0.343	2.220	3.308	0.845	

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B.C. 372 to A.D. 1896.

Number.	T			ω	☊	i	q	a	U	e	Discoverer.
229 F.	1851	I	Ap. 1.9	200.2	209.5	11.4	1.700	3.819	7.462	0.555	
230 d'A.	1851	II	Jl. 8.7	174.5	148.4	13.9	1.173	3.444	6.390	0.659	d'Arrest.
231	1851	III	Ag. 26.2	87.3	223.7	38.2	0.984	313.	5544.	0.997	Brorsen.
232	1851	IV	S. 30.8	294.4	44.4	74.0	0.142	....	....	...	Brorsen.
233 E.	1852	I	Mr. 14.7	183.5	334.4	13.1	0.337	2.215	3.297	0.848	
234	1852	II	Ap. 19.6	37.2	317.2	131.1	0.905	....	....	...	Chacornac.
235 B.[A]	1852	III	S. 23.7	223.3	245.9	12.6	0.861	3.526	6.621	0.756	
235 B.[B]	1852	III	S. 23.1	223.3	245.9	12.6	0.861	3.525	6.619	0.756	
236	1852	IV	O. 12.8	57.1	346.2	40.9	1.250	15.44	60.7	0.919	Westphal.
237	1853	I	F. 24.0	275.8	69.6	159.7	1.092	....	....	...	Secchi.
238	1853	II	My. 9.8	199.2	41.0	122.2	0.909	84.9	782.3	0.989	Schweizer.
239	1853	III	S. 1.7	170.4	140.5	61.5	0.307	....	....	...	Klinkerfues.
240	1853	IV	O. 16.6	277.8	220.1	119.0	0.173	....	....	1.001	Bruhns.
241	1854	I	Ja. 3.9	170.9	227.0	113.9	2.045	....	....	...	van Arsdale.
242	1854	II	Mr. 24.0	101.6	315.5	97.5	0.277	....	....	...	
243	1854	III	Je. 22.0	74.6	347.7	108.7	0.648	....	....	...	Klinkerfues.
244	1854	IV	O. 27.5	129.9	324.5	40.9	0.799	119.6	1309.	0.993	Klinkerfues.
245	1854	V	D. 15.7	287.0	238.1	14.2	1.358	99.6	994.2	0.986	Winnecke, Dien.
246	1855	I	F. 5.1	323.1	189.7	128.6	2.194	63.	500.	0.965	Schweizer.
247	1855	II	My. 30.2	22.6	260.3	156.9	0.567	....	....	...	Donati.
248 E.	1855	III	Jl. 1.2	183.4	334.4	13.1	0.337	2.215	3.295	0.848	
249	1855	IV	N. 25.4	325.5	51.6	169.8	1.231	....	....	...	Bruhns.
250	1857	I	Mr. 21.4	121.6	313.2	87.9	0.772	....	....	...	d'Arrest.
251 Br.	1857	II	Mr. 29.3	14.0	101.8	29.8	0.621	3.130	5.538	0.802	Bruhns.
252	1857	III	Jl. 18.0	134.1	23.7	121.0	0.367	....	....	...	Klinkerfues.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	T		ω	☊	i	q	a	U	e	Discoverer.
407	1892 VI	D. 28.1	252.7	264 5	24.8	0.976	. . . .	. . . .	. . .	Brooks.
408	1893 I	Ja. 6.5	85.2	185.6	143.9	1.195	. . . .	. . . .	. . .	Brooks.
409	1893 II	Jl. 7.3	47.1	337.4	160.0	0.675	1254.	44409.	0.999+	Sperra.
410 Fi.	1893 III	Jl. 12.2	315.5	52.5	3.0	0.989	3.526	6.622	0.720	
411	1893 IV	S. 19.3	347.7	174.9	129.8	0.815	. . . .	. . . .	. . .	Brooks.
412	1894 I	F. 9.5	46.3	84.4	5.5	1.148	3.804	7.42	0.698	Denning.
413	1894 II	Ap. 13.5	324.3	206.3	87.1	0 983	. . . .	. . . .	. . .	Gale.
414 T_2	1894 III	Ap. 23.2	185.1	121.2	12.7	1.351	3.008	5.218	0.551	
415*	1894 IV	O. 12.2	296.6	48.7	3 0	1.392	3.252	5.863	0.572	E. Swift.
416 E.	1895 I	F. 4.7	184.0	334.7	12.9	0.341	2.218	3.303	0.846	
417	1895 II	Ag. 20.9	167.8	170.3	3.0	1.296	3 680	7.059	0 648	Swift.
418	1895 III	O. 21.1	298.8	83.1	76.2	0.843	. . . .	. . . .	. . .	Brooks.
419	1895 IV	D. 18.4	272.7	320.5	141.6	0.192	. . . .	. . . .	. . .	Perrine.

TABLE II. Comets Arranged in Order of ω.

ω	Numbers.			
0° to 5°	335	278	142	174
5 to 10	181	78	349	85
10 to 15	26	80	343	52
	211	396	157	175
	Br.	404		
15 to 20	377	11	322	89
20 to 25	40	178	137	247
	10	43	402	55

ω	Numbers.			
25° to 30°	259	182	77	274
	165			
30 to 35	121	18	372	217
	225	58	39	
35 to 40	364	376	92	234
	367			
40 to 45	267	362		
45 to 50	412	409		

ω	Numbers.			
50° to 55°	187			
55 to 60	219	279	236	120
	381	53	76	
60 to 65	386	112	108	326
65 to 70	O.	374	146	5
	391	128	353	36
	389			
70 to 75	192	277	243	

* De Vico's Comet of 1844.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	T	ω	☊	i	q	a	U	e	DISCOVERER.
279	1863 III Ap. 20.9	55.6	250.2	85.5	0.629	. . . .	. . . .	. . .	Respighi.
280	1863 IV N. 9.5	357.2	97.5	78.1	0.707	. . . .	. . . .	. . .	Tempel.
281	1863 V D. 27.8	115.7	304.7	64.5	0.772	. . . .	. . . .	. . .	Respighi.
282	1863 VI D. 29.2	78.1	105.0	83.3	1.313	. . . .	. . . .	. . .	Bäker.
283	1864 I Jl. 27.8	346.1	175.0	135.0	0.626	. . . .	. . . .	. . .	Donati.
284	1864 II Ag. 15.6	151.0	95.2	178.1	0.909	249.	3934.	0.996	Tempel.
285	1864 III O. 11.4	232.5	31.8	109.7	0.931	. . . .	. . . .	. . .	Donati, Toussaint.
286	1864 IV D. 22.5	118.5	203.2	48.9	0.771	. . . .	. . . .	. . .	Bäker.
287	1864 V D. 27.7	178.5	340.9	162.9	1.115	. . . .	. . . .	. . .	Bruhns.
288	1865 I Ja. 14.3	111.7	252.9	92.5	0.026	. . . .	. . . .	. . .	Abbott.
289 E.	1865 II My. 27.9	183.5	334.5	13.1	0.341	2.218	3.304	0.846	
290	1866 I Ja. 11.1	171.0	231.4	162.7	0.977	10.32	33.18	0.905	Tempel.
291 F.	1866 II F. 14.0	200.2	209.7	11.4	1.682	3.802	7.413	0.558	
292	1867 I Ja. 20.2	357.5	78.5	18.2	1.577	11.71	40.09	0.865	Stephan.
293 T_1	1867 II My. 23.9	135.0	101.2	6.4	1.563	3.189	5.695	0.510	Tempel.
294	1867 III N. 7.0	148.6	65.0	96.6	0.330	. . . .	. . . .	. . .	Bäker.
295 Br.	1868 I Ap. 17.4	14.8	101.2	29.4	0.597	3.109	5.482	0.808	
296	1868 II Je. 26.5	126.6	52.3	131.5	0.579	. . . .	. . . .	. . .	Winnecke.
297 E.	1868 III S. 14.6	183.7	334.5	13.1	0.334	2.212	3.289	0.849	
298 W.	1869 I Je. 29.9	162.4	113.6	10.8	0.781	3.150	5.592	0.752	
299	1869 II O. 9.9	188.2	311.5	111.7	1.231	. . . .	. . . .	. . .	Tempel.
300 T_2-S.	1869 III N. 18.8	106.2	296.8	5.4	1.063	3.109	5.483	0.658	Tempel, Swift.
301	1870 I Jl. 14.1	198.2	141.7	121.8	1.009	. . . .	. . . .	. . .	Winnecke, Tempel.
302	1870 II S. 2.2	354.9	12.9	99.3	1.817	. . . .	. . . .	. . .	Coggia.
303 d'A.	1870 III S. 22.7	172.3	146.4	15.7	1.280	3.507	6.57	0.635	

TABLE III. COMETS ARRANGED IN ORDER OF ☊.

☊		Numbers.			
0° to	5°	198	128	215	
5	10	358	86	339	390
		267			
10	15	6	302	76	20
		79	392	254	
15	20	130	388	48	
20	25	168	216	252	144
25	30	108	47	17	104
		4	270		
30	35	317	226	202	285
		337	5	90	124
35	40	365	50	16	
40	45	174	238	136	150
		H.	175	232	269
45	50	396	341	H.	87
		335	160	415	
50	55	H.	249	296	Fi.
		77	368		
55	60	H.	113	114	8
		188			
60	65	149	201	116	294
65	70	72	348	366	237
70	75	154	36	184	100
75	80	56	219	159	112
		211	292	$T._1$	95
80	85	59	58	111	418
		O.	15	412	268
85	90	393	85	338	43

☊		Numbers.			
85° to	90°	57	12		
90	95	155	361	164	227
		24	147	304	
95	100	284	31	347	280
		163	134		
100	105	395	Br.	T_1	381
		331	W.		
105	110	282	119	22	127
		103			
110	115	208	W.		
115	120	277	30	203	319
		192			
120	130	98	T_2	106	132
		109			
125	130	18	345	78	11
130	135	102	82	41	
135	140	376	373	275	383
		23	255	94	
140	145	146	239	21	110
		301			
145	150	272	d'A.	308	88
		179			
150	155	. . .	. . .	. . .	. . .
155	160	120	199	9	263
160	165	212	64	52	3
165	170	262	51		
170	175	417	122	67	217
		411	283		

☊		Numbers.			
175° to	180°	101	259	45	314
		138	161		
180	185	107	351	329	35
		177			
185	190	84	408	194	325
		7	75	246	
190	195	125	221	369	169
		397			
195	200	118	173		
200	205	253	225	286	362
		352			
205	210	228	413	Wo.	181
		13	406	83	19
		197	F.		
210	215	222	306	91	
215	220	224	171	320	71
		27	400	2	
220	225	240	231		
225	230	81	187	241	60
		49			
230	235	313	92	290	89
		166			
235	240	176	63	193	26
		8	245		
240	245	402	99		
245	250	377	379	B.	195
		354	343	133	34
250	255	279	316	330	278

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	*T*			ω	☊	*i*	*q*	*a*	*U*	*e*	Discoverer.
330	1877	VI	S. 11.2	143.2	251.0	102.2	1.576	. . . .	. . . .	. . .	Coggia.
331	1878	I	Jl. 20.7	177.6	102.3	78.2	1.392	. . . .	. . . .	. . .	Swift.
332 E.	1878	II	Jl. 26.2	183.7	334.7	13.1	0.333	2.212	3.285	0.849	
333 T_2	1878	III	S. 7.3	185.1	121.0	12.8	1.340	3.001	5.202	0.554	
334 Br.	1879	I	Mr. 30.5	14.9	101.3	29.4	0.590	3.101	5.470	0.810	
335	1879	II	Ap. 27.4	3.7	45.8	107.0	0.897	. . . .	. . . .	. . .	Swift.
336 T_1	1879	III	My. 7.1	159.5	78.8	9.8	1.771	3.295	5.982	0.463	
337	1879	IV	Ag. 29.3	84.3	32.4	107.8	0.991	. . . .	. . . .	. . .	Hartwig.
338	1879	V	O. 4.6	115.4	87.2	77.1	0.990	. . . .	. . . .	. . .	Palisa.
339	1880	I	Ja. 27.6	86.3	6.2	144.7	0.005	. . . .	. . . .	. . .	Gould.
340	1880	II	Jl. 1.7	145.2	257.3	123.1	1.814	. . . .	. . . .	. . .	Schaeberle.
341	1880	III	S. 6.9	323.1	45.3	141.9	0.355	. . . .	. . . .	. . .	Hartwig.
342 T_3-S.	1880	IV	N. 8.0	106.2	296.9	5.4	1.067	3.113	5.493	0.657	Swift.
343	1880	V	N. 9.4	11.7	249.4	60.7	0.660	. . . .	. . . .	. . .	Pechüle.
344 F.	1881	I	Ja. 22.7	201.2	209.6	11.3	1.738	3.854	7.566	0.549	
345	1881	II	My. 20.4	173.8	126.4	78.0	0.591	. . . .	. . . .	. . .	Swift.
346	1881	III	Je. 16.4	354.3	271.0	63.4	0.734	206.	2954.	0.996	Tebbutt.
347	1881	IV	Ag. 22.3	122.1	97.0	140.2	0.634	. . . .	. . . .	. . .	Schaeberle.
348	1881	V	S. 13.3	312.5	65.9	6.9	0.725	4.226	8.687	0.828	Denning.
349	1881	VI	S. 14.4	6.3	274.2	112.8	0.449	. . . .	. . . .	. . .	Barnard.
350 E.	1881	VII	N. 15.3	183.9	334.6	12.9	0.343	2.221	3.310	0.845	
351	1881	VIII	N. 19.8	118.0	181.4	144.8	1.923	72.1	612.3	0.973	Swift.
352	1882	I	Je. 10.5	209.0	204.9	73.8	0.061	. . . .	. . . .	0.999+	Wells.
353	1882	II	S. 17.2	69.6	346.0	142.0	0.008	84.	772.	0.999+	
354	1882	III	N. 13.0	254.3	249.1	96.2	0.955	1239.	43601.	0.999	Barnard.

TABLE IV—(*Continued*). Comets arranged in order of *i*.

i	Numbers.			
23°	. . . .			
24	407			
25	Wo.			
26	175			
27	. . . .			
28	44	18		
29	Br.	316		
30	213	Br.		
31	386	406	147	
32	269	45	108	43
	253			
33	58			
34	320	153	69	
35	. . . .			
36	. . . .			
37	56			
38	231	402		
39	. . . .			
40	173	228	101	236
	244			
41	321			
42	379	364		
43	152	132		
44	7	O.		
45	113	203		
46	11	204		

i	Numbers.			
47°	87	208		
48	267	216	286	
49	215			
50	. . . .			
51	118	38	128	
52	199			
53	192			
54	Tu.	167		
55	30	76		
56	383	205	138	390
57	137			
58	195	317		
59	362			
60	65	343		
61	106	239	82	
62	145			
63	142	70	392	346
64	121	281	48	
65	68			
66	387	319	226	
67	90	225		
68	227	92		
69	. . . .			
70	3	115		

i	Numbers.			
72°	97			
73	19	352		
74	148	P-B_N	232	381
75	. . . .			
76	418			
77	80	338	327	400
78	345	355	280	331
79	94	268	57	266
	270	194		
80	361	157		
81	111			
82	365	62		
83	282	107		
84	366			
85	224	211	271	277
	279	96	372	
86	. . . .			
87	413	305	369	250
88	52	77		
89	154	169	403	
90	1	176		
91	288	116	. . . . .	
92	. . . .			
93				

TABLE I—(Continued). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	T	ω	☊	i	q	a	U	e	DISCOVERER.
381	1888 III Jl. 31.1	59.2	101.5	74.2	0.902	....	.....	...	Brooks.
382 F.	1888 IV Ag. 19.9	201.2	209.6	11.3	1.738	3.854	7.566	0.549	
383	1888 V S. 13.0	291.1	137.6	56.4	1.533	....	.....	...	Barnard.
384	1889 I Ja. 31.2	340.5	357.4	166.4	1.814	....	.....	...	Barnard.
385	1889 II Je. 10.8	236.1	310.7	163.8	2.255	....	.....	...	Barnard.
386	1889 III Je. 20.8	60.1	271.0	31.2	1.103	25.5	128.3	0.957	Barnard.
387	1889 IV Jl. 19.3	345.9	286.2	66.0	1.040	298.	5127.	0.996	Davidson.
388	1889 V S. 30.3	343.6	18.0	6.1	1.950	3.684	7.072	0.471	Brooks.
389	1889 VI N. 29.5	69.7	330.6	10.2	1.354	4.176	8.534	0.676	Swift.
390	1890 I Ja. 26.5	199.9	8.4	56.7	0.270	....	.....	...	Borelly.
391	1890 II Je. 1.5	68.9	320.3	120.6	1.907	....	.....	...	Brooks.
392	1890 III Jl. 8.5	85.7	14.3	63.3	0.764	....	.....	...	Coggia.
393	1890 IV Ag. 7.2	331.4	85.4	154.3	2.047	....	.....	...	Zona.
394 d'A.	1890 V S. 17.5	173.0	146.3	15.7	1.324	3.551	6.691	0.627	
395	1890 VI S. 24.5	163.0	100.1	98.9	1.260	....	.....	...	Denning.
396	1890 VII O. 26.1	13.1	45.1	12.9	1.818	3.448	6.402	0.473	Spitaler.
397	1891 I Ap. 27.5	178.9	193.9	120.5	0.397	....	.....	...	Barnard.
398 Wo.	1891 II S. 3.4	172.8	206.4	25.2	1.593	3.597	6.821	0.557	
399 E.	1891 III O. 18.0	184.0	334.7	12.9	0.340	2.218	3.303	0.846	
400	1891 IV N. 12.9	268.6	217.6	77.7	0.977	....	.....	...	Barnard.
401 Ts-S.	1891 V N. 15.0	106.7	296.5	5.4	1.087	3.129	5.534	0.653	
402	1892 I Ap. 6.7	24.5	240.9	38.7	1.027	740.	20143.	0.999	Swift.
403	1892 II My. 11.2	129.3	253.4	89.7	1.971	....	.....	...	Denning.
404	1892 III Je. 13.2	14.2	331.7	20.8	2.139	3.626	6.904	0.410	Holmes.
405 W.	1892 IV Je. 30.9	172.1	104.1	14.5	0.887	3.235	5.818	0.726	
406	1892 V D. 11.1	170.3	206.7	31.2	1.428	3.384	6.226	0.578	Barnard.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

Number.	*T*			ω	☊	*i*	*q*	*a*	*U*	*e*	Discoverer.
355	1883	I	F. 18.9	110.9	278.1	78.1	0.760	831.	23946.	0.999+	Brooks.
356	1883	II	D. 25.3	138.7	264.4	115.0	0.310	. . . .	. . . .	. . .	Ross.
357 P-Bs.	1884	I	Ja. 25.7	199.2	254.1	74.0	0.776	17.2	71.56	0.955	Brooks.
358	1884	II	Ag. 16.5	301.0	5.1	5.5	1.279	3.078	5.400	0.584	Barnard.
359 Wo.	1884	III	N. 17.8	172.7	206.3	25.3	1.571	3.580	6.774	0.561	Wolf.
360 E.	1885	I	Mr. 7.6	183.9	334.6	12.9	0.342	2.220	3.307	0.846	
[illegible]	1885	II	Ag. 5.7	178.5	92.3	80.6	2.507	. . . .	. . . .	. . .	Barnard.
[illegible]	1885	III	Ag. 10.4	43.4	204.5	59.3	0.755	. . . .	. . . .	. . .	Brooks.
[illegible] Tu.	1885	IV	S. 11.1	206.8	269.7	54.3	1.024	5.742	13.76	0.822	
[illegible]	1885	V	N. 25.5	35.6	262.2	42.4	1.080	. . . .	. . . .	. . .	Brooks.
[illegible]	[illegible]	[illegible]	Ap. 6.0	126.6	36.4	82.6	0.642	. . . .	. . . .	. . .	Fabry.
[illegible]	[illegible]			119.6	68.3	84.4	0.479	. . . .	. . . .	1.0002	Barnard.
[illegible]				[illegible]	287.8	100.2	0.842	. . . .	. . . .	. . .	Brooks.
[illegible]					53.5	12.7	1.327	3.152	5.595	0.579	Brooks.
						87.7	0.270	. . . .	. . . .	. . .	Brooks.
							0.885	3.234	5.816	0.726	
									6.648	0.718	Finlay.
										. . .	Barnard.

TABLE I—(*Continued*). Approximate elements of all computed orbits of comets from B. C. 372 to A. D. 1896.

NUMBER.	T	ω	☊	i	q	a	U	e	DISCOVERER.
407	1892 VI D. 28.1	252.7	264.5	24.8	0.976	. . . .	. . . .	. . .	Brooks.
408	1893 I Ja. 6.5	85.2	185.6	143.9	1.195	. . . .	. . . .	. . .	Brooks.
409	1893 II Jl. 7.3	47.1	337.4	160.0	0.675	1254.	44409.	0.999+	Sperra.
410 Fi.	1893 III Jl. 12.2	315.5	52.5	3.0	0.989	3.526	6.622	0.720	
411	1893 IV S. 19.3	347.7	174.9	129.8	0.815	. . . .	. . . .	. . .	Brooks.
412	1894 I F. 9.5	46.3	84.4	5.5	1.148	3.804	7.42	0.698	Denning.
413	1894 II Ap. 13.5	324.3	206.3	87.1	0.983	. . . .	. . . .	. . .	Gale.
414 T_2	1894 III Ap. 23.2	185.1	121.2	12.7	1.351	3.008	5.218	0.551	
415*	1894 IV O. 12.2	296.6	48.7	3.0	1.392	3.252	5.863	0.572	E. Swift.
416 E.	1895 I F. 4.7	184.0	334.7	12.9	0.341	2.218	3.303	0.846	
417	1895 II Ag. 20.9	167.8	170.3	3.0	1.296	3.680	7.059	0.648	Swift.
418	1895 III O. 21.1	298.8	83.1	76.2	0.843	. . . .	. . . .	. . .	Brooks.
419	1895 IV D. 18.4	272.7	320.5	141.6	0.192	. . . .	. . . .	. . .	Perrine.

TABLE II. COMETS ARRANGED IN ORDER OF ω.

ω	NUMBERS.	ω	NUMBERS.	ω	NUMBERS.
0° to 5°	335 278 142 174	25° to 30°	259 182 77 274	50° to 55°	187
5 10	181 78 349 85		165	55 60	219 279 236 120
10 15	26 80 343 52	30 35	121 18 372 217		381 53 76
	211 396 157 175		225 58 39	60 65	386 112 108 326
	Br. 404	35 40	364 376 92 234	65 70	O. 374 146 5
15 20	377 11 322 89		367		391 128 353 36
20 25	40 178 137 247	40 45	267 362		389
	[illegible]	45 50	412 400	[illegible]	[illegible]

TABLE II—(*Continued*). Comets arranged in order of ω.

ω		Numbers.			
75°	to 80°	8	206	104	268
		282	70	212	9
80	85	61	69	7	14
		198	337		
85	90	408	167	392	339
		373	12	231	67
		97	48		
90	95	304	24	30	218
		321	16	215	
95	100	255	134	306	260
		119	63	81	214
100	105	99	45	242	329
		22	H.	83	98
105	110	168	T_3-S.	H.	4
		73	62		
110	115	H.	355	288	154
		122	204	145	
115	120	338	96	281	327
		351	286	86	124
		366	46		
120	125	1	6	17	20
		250	347	199	254
125	130	19	296	365	116
		262	403	220	38
		82	244		
130	135	144	195	252	
135	140	T_1	135	107	194
		356			
140	145	330			
145	150	340	126	294	320

ω		Numbers.			
150°	to 155°	3	177	284	72
		87	319	275	125
155	160	263	60	111	193
		T_1	375	64	21
160	165	W.	395	74	
165	170	29	417	160	27
170	175	406	239	241	290
		W.	d'A.	Wo.	345
175	180	368	100	169	331
		203	361	287	397
180	185	15	153	227	253
		164	E.	130	
185	190	T_2	35	23	299
		31			
190	195	313	34		
195	200	316	301	238	P-Bs.
		390			
200	205	F.	71	369	184
205	210	150	205	115	Tu
		224	352	266	
210	215	188	202	B.	270
215	220	133	B.	136	
220	225	B.	305	102	
225	230	141			
230	235	88	276	285	314
235	240	385	226	163	109
		127			
240	245	197	41	308	228
245	250	90	37		
250	255	407	143	110	216

ω		Numbers.			
250°	to 255°	354			
255	260	8	47	171	179
260	265	103	186	222	
265	270	91	400	317	
270	275	419	94		
275	280	237	221	13	240
		44	201	173	176
		131			
280	285	265			
285	290	245	56		
290	295	383	232		
295	300	415	418		
300	305	57	358	95	152
305	310	51	75		
310	315	59	269	348	106
		147			
315	320	Fi.			
320	325	246	341	118	
		413			
325	330	249	84	101	
330	335	271	68	50	79
		393	272	318	138
		49	166		
335	340	114	208	213	
340	345	384	132	388	161
345	350	387	283	325	411
		155			
350	355	2	159	65	149
		346	113	302	
355	360	32	280	292	379

TABLE III. Comets arranged in order of ☊.

☊		Numbers.			
0°	to 5°	198	128	215	
5	10	358	86	339	390
		267			
10	15	6	302	76	20
		79	392	254	
15	20	130	388	48	
20	25	168	216	252	144
25	30	108	47	17	104
		4	270		
30	35	317	226	202	285
		337	5	90	124
35	40	365	50	16	
40	45	174	238	136	150
		H.	175	232	269
45	50	396	341	H.	87
		335	160	415	
50	55	H.	249	296	Fi.
		77	368		
55	60	H.	113	114	8
		188			
60	65	149	201	116	294
65	70	72	348	366	237
70	75	154	36	184	100
75	80	56	219	159	112
		211	292	T_1	95
80	85	59	58	111	418
		O.	15	412	268
85	90	393	85	338	43

☊		Numbers.			
85°	to 90°	57	12		
90	95	155	361	164	227
		24	147	304	
95	100	284	31	347	280
		163	134		
100	105	395	Br.	T_1	381
		331	W.		
105	110	282	119	22	127
		103			
110	115	208	W.		
115	120	277	30	203	319
		192			
120	130	98	T_2	106	132
		109			
125	130	18	345	78	11
130	135	102	82	41	
135	140	376	373	275	383
		23	255	94	
140	145	146	239	21	110
		301			
145	150	272	d'A.	308	88
		179			
150	155	. . .	. . .	. . .	. . .
155	160	120	199	9	263
160	165	212	64	52	3
165	170	262	51		
170	175	417	122	67	217
		411	283		

☊		Numbers.			
175°	to 180°	101	259	45	314
		138	161		
180	185	107	351	329	35
		177			
185	190	84	408	194	325
		7	75	246	
190	195	125	221	369	169
		397			
195	200	118	173		
200	205	253	225	286	362
		352			
205	210	228	413	Wo.	181
		13	406	83	19
		197	F.		
210	215	222	306	91	
215	220	224	171	320	71
		27	400	2	
220	225	240	231		
225	230	81	187	241	60
		49			
230	235	313	92	290	89
		166			
235	240	176	63	193	26
		8	245		
240	245	402	99		
245	250	377	379	B.	195
		354	343	133	34
250	255	279	316	330	278

TABLE III—(*Continued*). Comets arranged in order of ☊.

☊	Numbers.	☊	Numbers.	☊	Numbers.
250° to 255°	321 B. 288 148	285° to 290°	37 387 367 38	325° to 330°	260 39 274 135
	P-B_8 403	290 295	55 10		131 1
255 260	153 340 B. 372	295 300	T_3-S. 62 74 44	330 335	53 389 404 E.
260 265	247 213 32 214	300 305	165 281	335 340	46 204 409 206
	364 115 356 407	305 310	145 220 40		182 218 374
265 270	142 68 29 Tu.	310 315	137 80 385 299	340 345	287
270 275	1 346 386 65		250	345 350	353 327 236 205
	157 318 349	315 320	242 326 234 178		243 96
275 280	355 271 167 305	320 325	391 419 73 141	350 355	14 121 69
	70 375		143 152 186 266	355 360	276 97 61 265
280 285	322 126		244		384

TABLE IV. Comets arranged in order of *i*.

i	Numbers.	*i*	Numbers.	*i*	Numbers.
0°	. . . .	8°	100	15°	d'A.
1	102 85	9	159 T_1 35	16	21
2	64 201			17	B. 377
3	415 Fi. 417	10	8 389 W.	18	292 81
4	10 75	11	104 W. F.	19	220 259
5	T_3-S. 358 412	12	B. $B.^A$ $B.^B$ 368		
6	187 20 50 388		91 T_2 E. 396	20	404
	T_1 348	13	E. B. 34 d'A.	21	39 181 55
7	186	14	245 W.	22	71

TABLE IV—(*Continued*). Comets arranged in order of *i*.

i	Numbers.			
23°	. . . .			
24	407			
25	Wo.			
26	175			
27	. . . .			
28	44	18		
29	Br.	316		
30	213	Br.		
31	386	406	147	
32	269	45	108	43
	253			
33	58			
34	320	153	69	
35	. . . .			
36	. . . .			
37	56			
38	231	402		
39	. . . .			
40	173	228	101	236
	244			
41	321			
42	379	364		
43	152	132		
44	7	O.		
45	113	203		
46	11	204		

i	Numbers.			
47°	87	208		
48	267	216	286	
49	215			
50	. . . .			
51	118	38	128	
52	199			
53	192			
54	Tu.	167		
55	30	76		
56	383	205	138	390
57	137			
58	195	317		
59	362			
60	65	343		
61	106	239	82	
62	145			
63	142	70	392	346
64	121	281	48	
65	68			
66	387	319	226	
67	90	225		
68	227	92		
69	. . . .			
70	3	115		
71	. . . .			

i	Numbers.			
72°	97			
73	19	352		
74	148	P-B$_8$	232	381
75	. . . .			
76	418			
77	80	338	327	400
78	345	355	280	331
79	94	268	57	266
	270	194		
80	361	157		
81	111			
82	365	62		
83	282	107		
84	366			
85	224	211	271	277
	279	96	372	
86	. . . .			
87	413	305	369	250
88	52	77		
89	154	169	403	
90	1	176		
91	. . . .			
92	288	116		
93	. . . .			

TABLE IV—*(Continued).* Comets arranged in order of *i*.

i	Numbers.			
94°	89			
95	265	222		
96	313	354	294	218
97	67	242		
98	308	150	395	
99	322	302		
100	260	367	217	14
	88	63		
101	373			
102	306	330	177	
103	135	165	60	
104	31	375	47	
105	40			
106	197	160		
107	146	335	337	110
108	221	243		
109	73	285		
110	46			
111	22	299		
112	84	278	349	
113	275	241		
114	. . . .			
115	356	130	329	
116	124			
117	262	155		
118	. . . .			

i	Numbers.			
119°	240	49	127	
120	12	397	391	193
121	252	9	326	314
	301			
122	238	212		
123	340	168	254	
124	83			
125	166	179		
126	109	161		
127	98	164	29	
128	53	246	114	
129	134	131	411	
130	79			
131	126	234	206	202
	296	119		
132	. . . .			
133	. . . .			
134	143	86		
135	41	283	182	
136	178	184		
137	276	133	374	
138	272	74		
139	99	24	5	376
140	125	347	144	
141	419	341		

i	Numbers.			
142°	36	353	255	
143	163	408		
144	61	198	339	351
145	141			
146	171			
147	304	219		
148	26	318	103	78
149	. . . .			
150	1	122	51	214
151	. . . .			
152	27	112		
153	325			
154	393			
155	32			
156	247			
157	. . . .			
158	59	263	149	
159	136	237		
160	2	409		
161	. . . .			
162	H.	16	290	287
163	15	H.	17	6
	385			
164	. . . .			

TABLE IV—(*Continued*). Comets arranged in order of *i*.

i	Numbers.	*i*	Numbers.	*i*	Numbers.
165°	. . . .	170°	13 4 37 188	175°	95
166	384	171	. . . .	176	. . . .
167	23 120	172	274	177	. . . .
168	13	173	. . . .	178	284
169	72 249	174	174	179	. . . .

TABLE V. Comets arranged in order of *q*.

q	Numbers.			
0.00 to 0.05	1	61	374	339
	65	198	353	288
	176	216	317	152
.05 .10	352	70	52	160
	109			
.10 .15	60	101	182	179
	232			
.15 .20	49	240	47	174
	419			
.20 .25	265	92	87	81
	165			
.25 .30	203	136	369	390
	242	46	63	268
.30 .35	239	356	22	222
	44	32	221	294

q	Numbers.			
0.30 to 0.35	E.	69	91	157
	8	119		
.35 .40	341	252	7	30
	314	41	304	56
	143	118	397	100
.40 .45	206	127	116	76
	58	5	349	
.45 .50	186	26	366	132
	37	220	45	31
	97			
.50 .55	197	161	99	177
	322	187	55	110
	43	86	131	103
	260			
.55 .60	14	98	67	254

q	Numbers.			
0.55 to 0.60	228	53	247	15
	51	262	296	H.
	13	16	4	Br.
	345	166	74	
.60 .65	48	12	144	192
	Br.	90	283	135
	279	214	347	23
	365	142	75	243
.65 .70	Br.	305	343	373
	211			
	102	83	409	319
	269	308	62	153
	379	149		
.70 .75	34	280	114	108
	17	6	348	72
	316	346	19	38

TABLE V—(*Continued*). Comets arranged in order of q.

q		Numbers.			
0.70 to	0.75	253	122	194	73
.75	.80	362	121	35	355
		392	W.	84	286
		250	281	29	P-B_8
		148			
		111	133	3	124
		313	277	94	244
.80	.85	276	325	178	411
		271	21	24	W.
		36	215	9	82
		272	134	89	367
		418	71	57	163
.85	.90	175	202	155	B.
		$B.^A$	$B.^B$	77	85
		169	W.	318	168
		159	226	335	
.90	.95	104	381	B.	204
		234	10	284	238
		181	270	18	285
		20			
.95	1.00	326	39	354	68

q		Numbers.			
0.95 to	1.00	224	112	11	275
		95	126	145	407
		290	400	27	274
		413	321	231	B.
		Fi.	338	337	79
1.00	1.05	25	376	255	301
		96	327	2	Tu.
		78	59	402	146
		387	167		
1.05	1.10	T_8-S.	120	278	329
		138	364	227	141
		306	237	137	50
1.10	1.15	386	287	106	115
		164	64	412	259
1.15	1.20	225	d'A.	184	201
		408	266	154	O.
1.20	1.25	O.	150	193	249
		299	171		
1.25	1.30	236	205	395	358
		d'A.	125	417	

q		Numbers.			
1.30 to	1.35	267	282	d'A.	368
		T_2			
1.35	1.40	T_2	389	245	212
		415	331	377	
1.40	1.45	40	406	263	107
1.45	1.50	113	372	195	208
		219			
1.50	1.55	128	213	383	
1.55	1.60	T_1	Wo.	330	292
		130	147		
1.60	1.65	199	375		
1.65	1.70	F.	320		
1.70	1.75	F.			
1.75	1.80	218	T_1		
1.80	1.85	384	340	302	396
1.90	2.00	391	351	388	403
2.00	2.10	173	188	241	393
2.10	2.20	217	404	246	88
2.20	2.50	385	361		
4.05		80			

TABLE VI. Comets arranged in order of *a*.

a	Numbers.	*a*	Numbers.	*a*	Numbers.
2.2 to 3.0	E. 159 100	5.5 to 6.0	213 Tu.	100 to 150	375 244 142
3.0 3.1	T_2 64 358	10.0 15.0	290 292	150 200	262 101 379 254
3.1 3.2	85 201 Br. T_3-S.	15.0 20.0	236 P-B_8 O. H.		179 308 208
	W. 368 102 T_1		148 211 220	200 250	346 146 313 193
3.2 3.3	W. 415 113 T_1	20.0 30.0	275 386		284
3.3 3.4	406	30.0 40.0	253 206	250 300	171 387 305
3.4 3.5	d'A. 396	40.0 50.0	320	300 350	164 231 263 255
3.5 3.6	B. 259 B.^{A} B.^{B}	50.0 60.0	195 271 270	350 400	377 97
	Fi. d'A. Wo.	60.0 70.0	214 246 198	400 500	226 65 216 327
3.6 3.7	404 417 388	70.0 80.0	351	500 1000	319 402 355 321
3.8 3.9	F. 412	80.0 90.0	353 238		227
4.0 4.5	389 348	90.0 100.0	147 245	1000 1500	354 218 409

TABLE VII. Comets arranged in order of *U*.

U	Numbers.	*U*	Numbers.	*U*	Numbers.
3.3 years	E.	6.2 to 6.4	406 d'A.	13 to 14	213 Tu.
4.8	159	6.4 6.6	396 d'A.	30 40	290
5.0 to 5.2	100	6.6 6.8	B. 259 B.^{B} B.^{A}	40 50	292
5.2 5.4	T_8 64 358		Fi. d'A. Wo. 85	60 70	236
5.4 5.6	201 Br. T_8-S. W.	6.8 7.0	Wo. 404	70 80	P-B_8 148 O. H. 211
	368	7.0 7.5	417 388 F. 412	80 90	220
5.6 5.8	W. 102 T_1	7.5 8.0	F.	100 200	275 386
5.8 6.0	W. 415 113 T_1	8.5 9.0	389 348	200 250	253 206

TABLE VII—(*Continued*). Comets arranged in order of *U*.

U	Numbers.				*U*	Numbers.				*U*	Numbers.			
300 to 500	320	195	271	270	2500 to 3000	179	308	208	346	7000 to 8000	97			
500 700	214	246	198	351	3000 3500	146	313			8000 9000	226	65		
700 1000	353	238	147	245	3500 4000	193	284			10000 20000	216	327	319	
1000 1500	375	244			4000 5000	171				20000 30000	402	355	321	227
1500 2000	142	262			5000 6000	387	305	164	231	40000 45000	354	218	409	
2000 2500	101	379	254		6000 7000	263	255	377						

TABLE VIII. Comets arranged in order of *e*.

e	Numbers.			
.400 to .500	404	T_1	388	396
.500 .550	T_1	F.		
.550 .600	T_2	113	F.	Wo.
	415	406	368	358
.600 .650	201	64	417	d'A.
.650 .700	T_3-S.	d'A.	259	389
	159	412		
.700 .750	Fi.	85	B.	W.
	213			
.750 .800	B.	W.	$B.^A$	$B.^B$
	102	Br.		
.800 .850	Br.	Tu.	348	E.

e	Numbers.			
.850 to .900	100	292		
.900 .950	290	236	O.	
.950 .960	P-B_8	148	386	
.960 .970	275	211	320	246
	H.			
.970 .980	195	351	220	
.980 .990	253	147	270	375
	271	245	238	
.990 .995	214	206	208	244
.995 .996	193	146	171	142
.996 .997	379	377	263	262
	164	284		

e	Numbers.			
.996 to .997	308	346	313	387
.997 .998	231	254	255	
.998 .999	327	305	226	
.999 1.000	218	402	97	319
	321	227	355	354
	101	179	409	216
	192	353	198	352
1.000 1.001	65	221	366	203
	376			
1.001 1.010	225	240		
1.010 1.012	141	155		

PLANETARY PHENOMENA FOR JULY AND AUGUST, 1896.

By Professor Malcolm McNeill.

July, 1896.

The Earth is in aphelion on July 3d, at 2 P. M., P. S. T.

Mercury is at greatest west elongation on July 3d, and remains a morning star until July 31st, when it comes to superior conjunction with the Sun. For the first twenty days of the month, it rises at least an hour before the Sun, and may be seen under good weather conditions. On the afternoon of July 13th, it passes seven minutes south of the third-magnitude star μ *Geminorum*, and, on the morning of July 29th, it is almost in exact coincidence with the fifth-magnitude star η *Cancri*. At that time, however, it is too near the Sun to be seen.

Venus is very close to the Sun throughout the month, passing superior conjunction with the Sun on the morning of July 9th, and changing from a morning to an evening star. It does not move very far from the Sun during the month, and at the end sets less than half an hour later. It is in perihelion on the morning of July 23d.

Mars, at the end of the month, rises before midnight. During the month it moves about twenty degrees east and seven degrees north from the western to the eastern part of the constellation *Aries*. It is beginning to draw nearer to the Earth somewhat rapidly, and to gain materially in brightness, but is still nearly twice as far away as it will be at its opposition in December.

Jupiter is too near the Sun for good observation, and, by the end of the month, it sets only half an hour later. During the month, it moves seven degrees eastward and southward in the constellation *Cancer*.

Saturn is in fair position in the southwestern sky in the evening. It is nearly stationary among the stars, moving a few minutes westward, and then turning and moving a few minutes eastward. It is, throughout the month, about two degrees north and a little west of the third-magnitude star α *Libræ*. The apparent minor axis of the outside ring is about seven-eighths of the diameter of the planet.

Uranus is near *Saturn*, crossing the meridian about half an hour later. It is about seven degrees east and four degrees south of *Saturn*. No conspicuous star is very near; but the fifth-magnitude ζ *Libræ* is two degrees east and one degree north of the planet. The planet itself is sixth-magnitude, and may be seen on a clear, moonless night, if one has reasonably sharp eyesight.

Neptune is a morning star, in the eastern part of the constellation *Taurus*. It is too faint to be seen without a telescope.

AUGUST, 1896.

Eclipses. There will be two eclipses during the month. The first is a *total eclipse of the Sun*, on August 9th. The line of totality begins in the North Atlantic Ocean, touches the continent in the extreme northern part of Norway, then across the Arctic Ocean through Nova Zembla, into and across Siberia southeast to the coast, and through the island Yezo, ending in the Pacific Ocean about longitude 180°, latitude 20°. The extreme duration of totality is considerably less than three minutes. The stations most convenient of access are in Norway, where the duration of totality is less than two minutes, and on the island of Yezo, where the duration is about two and one-half minutes.

The second eclipse will be a *partial eclipse of the Moon*, on the night of August 22d–23d, and will be visible in the Western Hemisphere. The Moon enters the shadow at $9^h\ 24^m$ P. M., P. S. T., and leaves the shadow at $12^h\ 30^m$ A. M. The maximum obscuration, which occurs at $10^h\ 57^m$ P. M., is about three-quarters of the Moon's diameter.

Occultations. The Moon will again pass over the *Pleiades* on the early morning of August 3d, and a number of occultations may be seen in almost any part of the country. The immersions will be at the bright limb, and the emersions at the dark limb.

Mercury is an evening star, but is too close to the Sun to be easily seen, except, perhaps, in the latter part of the month, when it sets about an hour later, and may possibly be seen in clear weather. It will come to greatest eastern elongation on September 13th.

Venus is also an evening star, but is still very close to the Sun. By the end of the month it sets only forty minutes later. As it

is also at nearly its greatest distance from us, it will not be a very conspicuous object.

Mars is rising earlier, at $10^h\ 35^m$ on August 31st, and is getting brighter. At the end of the month, its distance from us is about equal to the Earth's distance from the Sun. During the month, it moves about nineteen degrees eastward and four degrees northward, in the constellation *Taurus*, passing between the *Pleiades* and the *Hyades* about August 15th.

Jupiter is too near the Sun to be seen. It passes conjunction with the Sun and changes from an evening to a morning star on the morning of August 12th.

Saturn is still an evening star, but is setting earlier each night; by the end of the month, it sets a little after nine. It is in the constellation *Libra*, north and a little east of the third magnitude star α *Libræ*. During the month, it moves about one degree eastward. The apparent opening of the rings is a trifle greater than during July.

Uranus occupies about the same position relative to *Saturn* as during July. Its motion among the stars is about half as great as that of *Saturn*, and is in the same general direction, eastward. At the end of the month, it is in about the same position it occupied on July 1st. The whole motion during the month is about half a degree, the apparent diameter of the Moon.

Neptune remains in about the same position in *Taurus*. By the end of the month, it rises before midnight.

Explanation of the Tables.

The phases of the Moon are given in Pacific Standard time. In the tables for Sun and planets, the second and third columns give the Right Ascension and Declination for Greenwich noon. The fifth column gives the local mean time for transit over the Greenwich meridian. To find the local mean time of transit for any other meridian, the time given in the table must be corrected by adding or subtracting the change per day, multiplied by the fraction whose numerator is the longitude from Greenwich in hours, and whose denominator is 24. This correction is seldom much more than 1^m. To find the standard time for the phenomenon, correct the local mean time by *adding* the difference between standard and local time if the place is west of the standard meridian, and *subtracting* if east. The same rules apply

to the fourth and sixth columns, which give the local mean times of rising and setting for the meridian of Greenwich. They are roughly computed for Lat. 40°, with the noon Declination and time of meridian transit, and are intended as only a rough guide. They may be in error by a minute or two for the given latitude, and for latitudes differing much from 40° they may be several minutes out.

Phases of the Moon, P. S. T.

		H. M.
Last Quarter,	July 2,	5 23 P. M.
New Moon,	July 10,	11 35 A. M.
First Quarter,	July 17,	8 4 A. M.
Full Moon,	July 24,	9 45 A. M.

The Sun.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
July 1.	6 44	+23 4	4 41 A.M.	12 4 P.M.	7 27 P.M.
11.	7 25	+22 1	4 46	12 5	7 24
21.	8 5	+20 20	4 54	12 6	7 18
31.	8 45	+18 6	5 3	12 6	7 9

Mercury.

July 1.	5 14	+19 31	3 25 A.M.	10 34 A.M.	5 43 P.M.
11.	6 1	+21 59	3 22	10 41	6 0
21.	7 17	+22 52	3 55	11 18	6 41
31.	8 45	+19 48	4 57	12 7 P.M.	7 17

Venus.

July 1.	6 34	+23 41	4 27 A.M.	11 54 A.M.	7 21 P.M.
11.	7 28	+22 45	4 46	12 8 P.M.	7 30
21.	8 20	+20 42	5 7	12 21	7 35
31.	9 11	+17 40	5 28	12 32	7 34

Mars.

July 1.	1 53	+ 9 50	12 39 A.M.	7 13 A.M.	1 47 P.M.
11.	2 20	+12 14	12 19	7 1	1 43
21.	2 47	+14 25	11 58 P.M.	6 48	1 38
31.	3 13	+16 21	11 38	6 35	1 32

Jupiter.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
July 1.	8 55	+ 18 6	7 12 A.M.	2 15 P.M.	9 18 P.M.
11.	9 3	+ 17 32	6 43	1 44	8 45
21.	9 12	+ 16 55	6 14	1 13	8 12
31.	9 21	+ 16 17	5 45	12 42	7 39

Saturn.

July 1.	14 44	− 13 20	2 48 P.M.	8 2 P.M.	1 16 A.M.
11.	14 43	− 13 20	2 8	7 22	12 36
21.	14 43	− 13 23	1 29	6 43	11 57 P.M.
31.	14 44	− 13 28	12 50	6 4	11 18

Uranus.

July 1.	15 14	− 17 41	3 34 P.M.	8 32 P.M.	1 30 A.M.
11.	15 13	− 17 38	2 54	7 52	12 50
21.	15 12	− 17 37	2 14	7 12	12 10
31.	15 12	− 17 37	1 34	6 32	11 30 P.M.

Neptune.

July 1.	5 11	+ 21 36	3 14 A.M.	10 31 A.M.	5 50 P.M.
11.	5 12	+ 21 37	2 36	9 53	5 10
21.	5 14	+ 21 39	1 58	9 15	4 32
31.	5 15	+ 21 40	1 20	8 37	3 54

Phases of the Moon, P. S. T.

		H. M.
Last Quarter,	August 1,	10 34 A. M.
New Moon,	August 8,	9 2 P. M.
First Quarter,	August 15,	1 2 P. M.
Full Moon,	August 22,	11 4 P. M.
Last Quarter,	August 31,	2 55 A. M.

The Sun.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Aug. 1.	8 48	+ 17 50	5 4 A.M.	12 6 P.M.	7 8 P.M.
11.	9 27	+ 15 4	5 13	12 5	6 57
21.	10 4	+ 11 52	5 22	12 3	6 44
31.	10 41	+ 8 23	5 31	12 0 M.	6 29

Mercury.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Aug. 1.	8 54	+19 17	5 3 A.M.	12 11 P.M.	7 19 P.M.
11.	10 11	+12 51	6 5	12 50	7 35
21.	11 14	+ 5 29	6 55	1 13	7 31
31.	12 7	+ 1 39	7 21	1 26	7 31

Venus.

Aug. 1.	9 16	+17 19	5 33 A.M.	12 33 P.M.	7 33 P.M.
11.	10 4	+13 24	5 56	12 42	7 28
21.	10 51	+ 8 52	6 19	12 50	7 21
31.	11 37	+ 3 57	6 43	12 56	7 9

Mars.

Aug. 1.	3 15	+16 32	11 37 P.M.	6 35 A.M.	1 33 P.M.
11.	3 41	+18 11	11 16	6 20	1 24
21.	4 6	+19 34	10 56	6 5	1 14
31.	4 29	+20 42	10 35	5 49	1 3

Jupiter.

Aug. 1.	9 21	+16 13	5 42 A.M.	12 39 P.M.	7 36 P.M.
11.	9 30	+15 32	5 14	12 8	7 2
21.	9 39	+14 51	4 47	12 38 A.M.	6 29
31.	9 47	+14 9	4 19	11 7	6 55

Saturn.

Aug. 1.	14 44	−13 29	12 46 P.M.	6 0 P.M.	11 14 P.M.
11.	14 45	−13 38	12 9	5 22	10 35
21.	14 47	−13 49	11 33 A.M.	4 45	9 57
31.	14 49	−14 3	10 56	4 8	9 20

Uranus.

Aug. 1.	15 12	−17 37	1 30 P.M.	6 29 P.M.	11 28 P.M.
11.	15 13	−17 38	12 51	5 50	10 49
21.	15 13	−17 41	12 13	5 11	10 9
31.	15 14	−17 45	11 36 A.M.	4 33	9 30

NEPTUNE.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Aug. 1.	5 15	+21 40	1 15 A.M.	8 33 A.M.	3 51 P.M.
11.	5 16	+21 41	12 37	7 55	3 13
21.	5 17	+21 41	11 58 P.M.	7 16	2 34
31.	5 18	+21 42	11 20	6 38	1 56

(TWENTY-SECOND) AWARD OF THE DONOHOE COMET-MEDAL.

The Comet-Medal of the Astronomical Society of the Pacific has been awarded to Mr. C. D. PERRINE, Assistant Astronomer in the LICK Observatory, for his discovery of an unexpected comet on February 15, 1896.

The Committee on the Comet-Medal,

EDWARD S. HOLDEN,
J. M. SCHAEBERLE,
W. W. CAMPBELL.

April 15, 1896.

REPORTED VOLCANIC ERUPTIONS.

FROM RECORD IN OFFICE OF FREDERICK G. PLUMMER, C. E., TACOMA, WASH.

TACOMA, Wash., March 13, 1896.

PROF. E. S. HOLDEN, Director LICK Observatory, Cal.

Sir:—The matter contained in my letter of March 3d also applies to the table of reported volcanic eruptions submitted herewith.

There can be no doubt that many eruptions are reported which might be contradicted if examination were possible. For example, the reports of the eruption and change in the summit of Mount Tacoma from November 21 to December 25, 1894, filled many columns of the press dispatches, and possibly were intended for that purpose. December 25th was the most perfect day for observation, and, with my 6½-inch refractor, the crater-

peak and its surroundings were carefully examined, and no change could be seen. No eruption was noted, other than the usual emission of steam, which varies with the barometer. However, reports came in later from a press party, which claimed to have reached the slope of the mountain, and witnessed an eruption of smoke. The party was about five miles from the summit, and my telescope, with low power, brought the summit within half a mile. Although this was the clearest and most definite report of eruption, yet it is so flatly contradicted by the continuous telescopic observations and the later examinations of climbers, that it is omitted from the table.

Very truly,

FRED. G. PLUMMER.

Date of Beginning. Year.	Day.	Name of Volcano.	Duration of Eruption.	Phenomena.
1690		Khaginak A.		A crater formed.
1700		On Amak Island A.	10 years	Occasionally active.
1741		Hiamna A.		
1760		Adakh A.		
1760		Goreloi A.		
1760		Chechitno A.		
1760		Atka A.		
1760		Koniushi A.		Island rose.
1762		Pavloff A.		
1763		Tanaga A.	7 years	
1763		Kanaga A.		Solfataras.
1768		Unalashka A.		
1768		Medviednikoff A.		
1768		Walrus A.		
1770		Amukhta A.		
1774		Four Craters A.		
1775		Calder A.		
1775		Unimak A.	3 years	Flames and smoke.
1776	July	Sitignak A.		Flames and smoke.
1778		Iliamna A.	92 years	Occasionally smoke.
1778		Shishaldin A.		
1784		Vsevidoff A.		
1784	July	Chechitno A.		
1786		Seguam A.	4 years	
1786		Amukhta A.	5 years	
1786		Kanaga A.		Flames and smoke.
1786		Pavloff A.		North crater fell in.
1790		Akutan A.		
1790		Vsevidoff A.		
1790		Kanaga A.		
1790		Semisphnoi A.		
1790		Makushin A.	2 years	Occasionally smoke.
1790		Shishaldin A.	35 years	Occasionally smoke.
1791	June	Tanaga A.		
1791	June	Kanaga A.		
1792		Great Sitkin A.		
1792	February ?	Goreloi A.	4 months	Flames.
1792	June 1	Semisopochnoi A		
1795		Unimak A.		SW. crater exploded and fell in.
1796		Edgecombe A.		
1796	May	Bogoslov A.		Terrible eruption of flames.
1796		Four Craters A.	4 years	
1796		Amak A.		
1802		Makushin A.		Flames and smoke.
1806		Bogoslov A.		Lava flow.
1812		Sarycheff A.		Violent eruption.

Date of Beginning. Year.	Day.	Name of Volcano.	Duration of Eruption.	Phenomena.
1817	April	Yunaska A.		
1817		Umnak A.		
1819		Wrangell A.		
1819		Redoubt A.		
1820		Bogoslov A.		
1824		Shisldin A.		
1824		Yunaska A.		
1825	March 10	Isanotski A.		
1826	October 11	Unimak A.		
1827		Shisldin A.	3 years	
1827		Pogrumnoi A.	2 years	
1827		Koniushi A.		
1827		Kanaga A.		
1828		Little Sitkin A.	2 years	
1828		Akhun A.	2 years	
1828		Akutan A.	2 years	
1828		Tanak-Angunakh A.	2 years	
1828		Atka A.	2 years	
1828		Koniushi A.	2 years	
1828		Goreloi A.	2 years	
1830		Korovin A.		
1830		Atka A.		
1830		Yunaska A.		
1830		Umnak A.		
1830	November	Unimak A.		Violent eruption.
1830		Veniaminoff A.		
1831		St. Helens W.	12 hours	
1831		Hood O.		
1832		St. Helens W.		
1838		Shishaldin A.		Flames.
1838		Four Craters A.		
1838		Makushin A.		
1838		Akutan A.		
1838		Veniaminoft A.		
1838		Pavloff A.		
1839		St. Elias A.		
1840		Cinder Cone A.		Cinders.
1841		Tacoma W.		
1841		St. Helens W.		
1842		St. Helens W.	2 months	Smoke and light ashes.
1842		Baker W.		
1843	November 13	St. Helens W.	10 days	Flames and light ashes.
1843	November 13	Tacoma W.		
1843	December ?	St. Helens W.	85 days	
1844		Korovin A.		
1844		Makushin A.		
1846		Hood O.		
1846		St. Helens W.		
1846		Baker W.		
1847		Baker W.		
1852		St. Helens W.		
1853	January	Baker W.		Slight lava flow.
1854	February	St. Helens W.	70 days	
1854	August	Hood O.		
1854	Summer	Baker W.		Smoke and ashes.
1859	August 15	Hood O.	2 days	
1859		Baker W.		
1860		Baker W.		
1861		Olympus W.		
1865		Shishaldin A.		
1865		Makushin A.		
1865	September 23	Hood O.	15 days	
1869		Hood O.	3 hours	
1873	Oct. 19, 4 P.M.	Tacoma W.	7 days	
1880	May	Tacoma W.		
1880	December	Baker W.		
1884	June 16	Tacoma W.	2 hours	Steam.
1891	Autumn	Baker W.		
1891	August 2	Chimney Peak C.		
1891		Hozomeen W.		Flame and smoke.
1892	August 27	Veniaminoff A.	3 days	
1892		Bogoslov A.		
1893	March 9	Olympus W.		
1894	January 17	Jefferson O.		Smoke and steam.
1895	Autumn	Bogoslov A.		Flames and smoke.

ON ASTRONOMICAL CIPHER CODES.

To the Secretary of the Astronomical Society of the Pacific:

In your *Publications*, No. 48, Professor E. S. HOLDEN contributes an article entitled, "Telegraphic Announcements of Astronomical Discoveries, Etc., in America." A portion of this article is historical, and another part describes the Science Observer code, with some ideas advanced by the author about the proper form of code.

It seems unnecessary to comment on the criticisms on the code, for these may be, after all, matters of opinion merely; but, since I am the person who made the bit of history which is reviewed, I claim the right to correct, through your columns, the version which has been given by Professor HOLDEN, and to set forth the real relations between Dr. CHANDLER and myself, and the telegraphic transmission of astronomical information in this country. These relations are obscured in Professor HOLDEN'S article. The story has already been set forth, first, briefly in the preface to the code (a source from which Professor HOLDEN drew some of his facts), and more at length in an article signed by me in the *Astronomical Journal* of March 23, 1888. This latter article is so clear and plain that there is only need of making a direct quotation from it.

The article in the *Astronomical Journal* announces the issue of the Science Observer code, and gives a brief history of the experimenting with the provisional code-book.

"In 1882," it goes on to say, "upon the formation of a European association of astronomers for announcements and for collection of news of astronomical discoveries, Dr. KRUEGER expressed a wish that the originators of the code [Dr. CHANDLER and I] would act as the center for the United States; and, shortly afterwards, Professor BAIRD, Superintendent of the Smithsonian Institution, tendered to Mr. CHANDLER and myself the department of international exchange of astronomical information. We felt, however, that in undertaking the work it could be most conveniently carried on by securing the co-operation of some established observatory. The reasons are obvious; and, among them, the aid which the instrumental equipment would afford. The nearness of Harvard College Observatory, together with the fact that Mr. CHANDLER had meanwhile become, and then was,

associated with it, made it the institution most naturally to be looked to for collaboration. Professor PICKERING, who had become interested in the project, kindly tendered the co-operation of the observatory; and, in default of any formal association of American observatories, like that then just formed in Europe, offered to defray the expense of cable messages relating to announcements of American discoveries. This offer of its influence and financial assistance was cheerfully accepted, and is gratefully acknowledged.

"To facilitate some necessary business arrangements, especially with the telegraph companies, which would more readily treat with the representative of an institution than with an individual, Professor PICKERING suggested the addition of my name to the staff of the observatory. The appointment being nominal and without compensation, I saw no objection to accepting.

"Meanwhile, as an undertaking intimately related to the foregoing, although independent of connection with any observatory in particular, it has been my constant endeavor to make more efficient the service which the circulars were intended to render. To this end, arrangements have been made from time to time with various observatories for the telegraphic interchange of positions of comets, for providing material for those who were willing to undertake orbit-computation, and, in the case of a widely-prevailing storm, for securing positions from observatories out of its range. The hearty encouragement and assistance met with in every direction in these endeavors calls for my sincere thanks."

To define Dr. CHANDLER'S relation to the whole matter more precisely than this article in the *Astronomical Journal* found it necessary to state, I may say that the plan of the code and many of its details were his, together with much advice and practical help in the technical matters connected with the orbits. The selection of the words, the preparation of the volume, the presentation of the plan to astronomers, the business matters relating to the transfer from the Smithsonian Institution, and other details were mine. It should further be said that, having personal acquaintance with Professor BAIRD, these matters were arranged by word of mouth, and, as might be expected in such a case, the formal correspondence, as printed in the Government reports, does not present the story in all its details.

JOHN RITCHIE, JR.

NOTE ON THE FOREGOING, BY PROFESSOR HOLDEN.

Those who are interested in the matter discussed by Mr. RITCHIE should note, *first*, that if the "relations are obscured" by anything which I have written, the obscuration was not intentional, as I took special pains to say in private letters addressed both to Dr. CHANDLER and to him; *second*, that the facts I give are all from official sources; and, *third*, that Mr. RITCHIE points out that the official correspondence as printed does not present the story in all its details. Mr. RITCHIE'S note should, then, be read in connection with the official papers from which I quoted. EDWARD S. HOLDEN.

ELEMENTS AND EPHEMERIS OF COMET *b*, 1896.

COMMUNICATED BY FREDERICK H. SEARES.

The following elements of Comet *b*, 1896, have been computed by Professor A. O. LEUSCHNER and myself:

$$T = \text{April } 17.6516 \text{ Gr. M. T.}$$

$$\left.\begin{array}{l} \omega = 1^\circ\ 45'\ \ 5'' \\ \Omega = 178\ \ 15\ \ 31 \\ \pi = 180\ \ \ 0\ \ 36 \\ i = 55\ \ 35\ \ 26 \end{array}\right\} 1896.0.$$

$$\log q = 9.75307$$

$$\text{O—C.}\quad \Delta\lambda \cos\beta = -1''.2. \quad \Delta\beta = +4''.4.$$

These elements are based upon observations made at the LICK Observatory by Professors HUSSEY and AITKEN on April 16th, 17th, and 19th, which were telegraphed to the Students' Observatory by Dr. HOLDEN. They do not present any special resemblance to any of the elements given in the available comet catalogues. The following ephemeris has also been computed.*

UNIVERSITY OF CALIFORNIA,
Students' Observatory, 1896, April 22.

OBSERVATIONS OF DARK MARKINGS ON *VENUS*, 1889.

BY EDWARD S. HOLDEN.

During the months of May and June, 1889, I examined the surfaces of the planets *Uranus*, *Saturn*, *Venus*, and *Mercury* on

* The ephemeris (for every day from April 23.5 to May 25.5) is omitted here.—*The Committee on Publication.*

every suitable occasion. *Venus* was observed every day, during daylight, with the twelve-inch or thirty-six-inch equatorial, and often in the morning twilight with the former instrument. On most occasions, there was little or nothing to record. On five dates I made sketches, showing the outlines of dark areas on the planet's disc. These diagrams are reproduced in the accompanying plate.* The dark areas in the plate are many times darker, relatively, to the paper than the corresponding very faint and elusive markings on *Venus*, relatively, to the brilliant surface of the planet. The dates recorded are the astronomical days. The best view of *Venus* was obtained on May 29th, an hour or so before noon. (*See* the two upper diagrams in the plate.)

At 3^h 18^m, Sid. time, with the twelve-inch equatorial, the first drawing was made. The southern half of the planet was much less bright than the northern. The surface was covered with a faint shading, and part of this shading (near P) was darker than the rest.

At 3^h 53^m, Sid. time, with the thirty-six-inch equatorial, a second sketch was made. (*See* the plate.) At P, there was an obvious notch in the terminator. At Q, a second notch was suspected. Near the south cusp, S, there was much detail which was too poorly seen to be drawn (at 4^h 30^m Sid. time).

At x x x, the planet is very bright. Some of the dark shadings may be due to contrast only. I believe the main outlines to represent real features. The notch P seems to be certain.

At 16^h 30^m, P. S. T., June 3d, with the twelve-inch equatorial, a sketch was made. (*See* the plate.) Besides the shading at the terminator, there are two regions, *a* and *b*, well seen.

At 16^h 50^m, P. S. T., June 10th, with the twelve-inch equatorial, a sketch was made. (*See* the plate.)

At x x x, the surface was very brilliant. At R, the terminator seemed serrated, "perhaps due to irradiation from x x x."

At 23^h, P. S. T., June 11th, with the twelve-inch equatorial, a sketch was made. (*See* the plate.) The image was poor. There appeared to be two dark areas, *a* and *b*, as drawn; and I could not be certain whether or no they were connected at ?.

I am inclined to think that much, if not all, of the dark shad-

* They have usually been copied from the observing books by tracing them on a piece of ground glass placed over the original sketches. The copies are then finished, photographed, and a paper-print sent to the engraver. I believe this is the most rapid and sure method of copying such diagrams.

ings of the last two sketches may be due to contrast with the very brilliant border of the planet. The shadings of 1889, June 3d, may be due to the same cause. Those of May 29th, are probably real, and may serve to compare with other drawings for the determination of the rotation-time.

THE COMPANION OF *SIRIUS*, AND ITS BRIGHTNESS ACCORDING TO PHOTOMETRIC THEORY.

By William J. Hussey.

The companion of *Sirius* was last observed by Professor Burnham in April, 1890, with the thirty-six-inch telescope of the Lick Observatory. In October, November, and December of that year, and in October of the following year, he examined *Sirius* on five nights under good conditions, but was unable to see the companion. At that time the companion was within 4″.2 of its primary, and the distance was decreasing. Since then, according to the elements that have been computed, it has passed its minimum distance, and at the beginning of this year (1896) was at about the same distance as when last observed in 1890. This being the case, it was expected that the companion could be observed again in the early part of this year. I have looked for it with the thirty-six-inch telescope as follows:

1896, February 9.—Examined *Sirius* carefully when near the meridian, using various powers, from 350 to 1900. Seeing good. Companion not seen.

February 14.—Seeing good. Companion not seen.

February 19.—Examined *Sirius* with powers 270, 1900, and 2600. The micrometer wire was set to the ephemeris place of the companion, and the entire region thereabouts examined carefully. Seeing good. Companion not seen.

March 11.—Examined *Sirius* with powers 350, 550, 1000, 1900, and 2600. Each eye-piece was provided with a diaphragm, accurately at its focus, covering half the field of view. By this means *Sirius* could be placed out of view, and the region close about it still examined. Seeing very good. Companion not seen.

March 12.—Examined *Sirius* with powers 350, 1000, 1500, 1900, and 2600. Eye-pieces were provided with diaphragms, as

before. Searched carefully from position-angle 90° to 270°, and at varying distances. Seeing good. Companion not seen.

All the observations were made when *Sirius* was near the meridian. Color screens of various shades were tried each night.

On the nights of March 11th and 12th, Professor CAMPBELL also looked for the companion, using various powers. Eyepieces provided with diaphragms. Color screens tried. The companion was not seen. On the last date he also examined the ephemeris region spectroscopically, with a slit sufficiently narrow to exclude most of the light of *Sirius*. The spectrum of the companion was not seen.

The companion of *Sirius* was first known by the disturbances it produced in the motion of *Sirius*. This was shown by BESSEL'S investigations in 1844. It was discovered visually early in 1862, and between that time and the date of the last observation in 1890 it described about 85° of position-angle. This arc is not sufficient to enable a certain determination of the elements of the orbit to be made. The various systems of elements that have already been computed differ considerably among themselves. For example: the periodic time according to AUWERS' elaborate investigation is 49.399 years (*Astr. Nach.*, Nos. 3084–85); according to HOWARD'S graphical construction, 57.02 years (*Astr. Journal*, No. 235); and according to GORE'S determination, 58.47 years (*Monthly Notices*, June, 1889). The other elements vary similarly.

With the parallax of *Sirius* as determined by GILL and ELKIN, 0".38, AUWERS has found—

Mass of *Sirius* = 2.20
Mass of companion = 1.04

the mass of the Sun being taken as unity. From this it appears that the mass of the companion is nearly half that of *Sirius* itself. That some such relation between the masses should exist was pointed out by Professor SAFFORD in 1863,* before it had become certain that the companion was the body indicated by theory; and more accurately by M. O. STRUVE in 1866, who wrote† as follows:

"Admitting that the observed satellite is identical with BESSEL'S obscure body, its mass must be estimated approximately half that of *Sirius* itself. If both bodies had the same physical

* *Proceedings of the American Academy of Arts and Sciences*, Vol. VI.
† *Monthly Notices*, Vol. 26, p. 270.

constitution, this relation of the masses would assign to the globe of the satellite a diameter only 1.26 times smaller than that of the principal body, and, therefore, considering the extraordinary brightness of the large star, we should be induced to place also the satellite in the class of first magnitude. With this conclusion, the observed brightness of the companion forms a manifest contradiction. It is commonly said to be of the ninth or tenth magnitude; and only in the spring of 1864 I have noted it once as of the eighth magnitude, probably on account of the extraordinary favorable state of the atmosphere. Hence, it follows that, to maintain the identity, we must admit that both bodies are of a very different physical constitution. That the light of the satellite is increasing, as I was inclined to suppose from the comparison of my observations of 1864 with those of 1863, has not been confirmed by later observations; but in our latitude* the estimation of the brightness depends too much on the condition of the atmosphere to admit of an accurate judgment in this respect."

According to AUWERS' investigation, the mean distance of the companion from *Sirius* is 19.92 astronomical units, or, approximately, the distance of *Uranus* from the Sun. It is doubtful whether a planet at that distance from its primary, and at the distance of *Sirius* from the Earth, would be visible if shining by reflected light alone. It is not without interest, however, to know what would be the variations of brightness of a planet so situated. I have, therefore, computed the brightness of the companion on this hypothesis, and give the results in the accompanying table. The brightness at the time of visual discovery has been taken as unity, and the results are given through one complete revolution. HOWARD'S elements have been used as the basis of the calculation.

In the case of a double star, the inclination as given does not uniquely determine the position of the plane of the orbit, but simply indicates two positions, one of which is the correct one. On this account, there are two cases to be considered. The values for both positions have been computed, and are given under the headings I and II, respectively.

Two sets of values for each position are given. One has been computed by EULER'S and the other by SEELIGER'S photo-

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* The latitude of Pulkowa is 59° 46′. The declination of *Sirius* is — 16° 34′. The meridian zenith distance of *Sirius* at Pulkowa is, therefore, 76° 20′.

metric formula. In accordance with EULER'S theory, the brightness varies as

$$\frac{\cos^2 \frac{1}{2}\alpha}{r^2},$$

and with SEELIGER'S theory as

$$\frac{1 - \sin \frac{1}{2}\alpha \tan \frac{1}{2}\alpha \log_e \cot \frac{1}{4}\alpha}{r^2},$$

where r is the distance of the companion from *Sirius* and α the phase-angle, or angle at the companion between *Sirius* and the Earth.

MT. HAMILTON, CAL., May 25, 1896.

BRIGHTNESS OF THE COMPANION OF *SIRIUS* IN TERMS OF ITS BRIGHTNESS AT DISCOVERY.

DATE.	EULER'S THEORY.		SEELIGER'S THEORY.		REMARKS.
	I.	II.	I.	II.	
1862.2	1.00	1.00	1.00	1.00	Discovery.
64.0	1.08	0.96	1.08	0.95	
66.0	1.18	0.94	1.19	0.92	
68.0	1.32	0.92	1.35	0.89	
1870.0	1.49	0.92	1.52	0.88	
72.0	1.70	0.92	1.75	0.87	
74.0	1.99	0.93	2.05	0.87	
76.0	2.37	0.96	2.47	0.88	
78.0	2.89	1.01	3.04	0.91	
1880.0	3.62	1.05	3.87	0.95	
82.0	4.73	1.11	5.11	0.98	
84.0	6.46	1.20	7.12	1.04	
86.0	9.39	1.29	10.60	1.09	
88.0	14.70	1.35	17.18	1.12	
1890.0	24.74	1.29	30.52	1.05	
90.27	26.91	1.27	33.21	1.03	Last observation.
92.0	42.51	1.14	54.73	0.91	
94.0	50.39	2.47	59.26	2.00	
96.0	27.65	4.97	30.52	4.31	
98.0	10.65	4.81	11.03	4.50	
1900.0	4.53	3.77	4.50	3.71	
2.0	2.60	2.93	2.41	2.98	
4.0	1.51	2.33	1.50	2.41	
6.0	1.14	1.94	1.13	2.01	
8.0	0.96	1.65	0.95	1.71	
1910.0	0.89	1.45	0.88	1.50	
12.0	0.82	1.30	0.81	1.35	
14.0	0.89	1.18	0.87	1.21	
16.0	0.90	1.10	0.89	1.11	
18.0	0.96	1.03	0.96	1.01	
1920.0	1.03	0.98	1.03	0.98	

INTERIOR VIEW OF LOWE OBSERVATORY, ECHO MOUNTAIN, CAL.

NOTICES FROM THE LICK OBSERVATORY.

PREPARED BY MEMBERS OF THE STAFF.

MEMORANDUM ON A PROPOSED OBSERVATORY ATLAS OF THE MOON FROM NEGATIVES TAKEN AT MOUNT HAMILTON.

It is proposed to publish a map of the Moon from negatives made with the thirty-six-inch refractor, on a scale of three Paris feet (= 97.45 *cm* = 38.36 English inches) to the Moon's diameter. This scale is chosen because it is the same as that of the charts made (visually) by MAEDLER and LOHRMANN, and exactly half the size of the (visual) map made by SCHMIDT. These excellent charts will serve as indexes to the proposed photographic map. Three feet is a scale very suitable for observatory uses. For other purposes, the large-scale maps now in process of construction by Professor WEINEK, at Prague, (chiefly from LICK Observatory negatives), and by the Paris Observatory (from their own excellent negatives), will be appropriate.

The plan, at present, is to make an observatory atlas of some sixty sheets, each about fifteen by eighteen inches, the image of the Moon on each being some eleven by fourteen inches. Three such sheets will show the whole terminator on a single date. Some eighteen or nineteen dates will be represented, each by at least three sheets. Charts of the full Moon, an index chart, and several pages of explanatory text will be added. It is hoped to issue the charts in heliogravure, from copperplates, similar to the plates in Volume III of the *Publications of the Lick Observatory*, quarto, 1894. Changes will be made in the plan, if desirable.

EDWARD S. HOLDEN.

MOUNT HAMILTON, April 11, 1896.

Astronomical Telegrams Received by and Sent fro[m] the Lick Observatory.

It is proposed, from now onward, to print in the *Notices fro[m] the Lick Observatory* copies or translations of the most import ant astronomical telegrams received by and sent from the Lic[k] Observatory. Telegrams received and sent during the yea[rs] 1888–1896 are preserved in a special file at Mount Hamilto[n]. All telegrams received here which announce any astronomic[al] news of importance have been regularly sent to the San Francisc[o] and San José newspapers by mail; and, in many cases, they hav[e] also been telegraphed. Astronomical news of importance, base[d] on observations at Mount Hamilton, is always telegraphed to th[e] Central Office of Astronomical Telegrams for America (the Har vard College Observatory) in cipher; and also communicated, b[y] telegraph or otherwise, to the Associated Press and to the Unite[d] Press agents in San Francisco. Whenever it seems desirab[le] special notices will be sent to the members of the Astronomic[al] Society of the Pacific. Edward S. Holden.

Mount Hamilton, April 16, 1896.

Discovery of Comet *b*, 1896, by Dr. Lewis Swift.

Pasadena, [Thursday] April 16, 1896.*

To Lick Observatory, San José.

Comet Monday. Ascension three thirty-nine, north fiftee[n] forty, from circles. Bright, short tail. Very slow westerly.

Collect. Lewis Swift.

The telegram indicates that the position refers to Monda[y] April 13th. As a matter of fact, it relates to Wednesday. Th[e] comet was found by Mr. Perrine, and observed by Messr[s]. Hussey and Campbell, about 8^h 30^m p. m. of Thursday. A[t] 9^h 23^m p. m., a telegram was received from Boston, which prove[d] to be a translation into cipher of Dr. Swift's telegram printe[d] above. Three of its cipher-words were distorted. At any rat[e] it was received too late to have been of any use, as no observa tions of the comet could have been made here after about 9 p. m.

* Received at Lick Observatory, April 16, 1896, 9.27 a. m.

Observations of Comet b, 1896, by Messrs. HUSSEY *and* AITKEN.

The observation of Professor HUSSEY gave the position April 16.6896 G. M. T.; R. A. $3^h\ 38^m\ 20^s.6$; Decl. $+18°\ 19'\ 32''$, and showed the comet to be moving very slowly westward, but northward at the rate of two and a half degrees daily. These facts were telegraphed at 11.03 P. M. to Harvard College Observatory, to the Students' Observatory, University of California, and to the press.

Telegram sent Friday, April 17th, at $10^h\ 45^m$ P. M. (translation): To H. C. O.—Comet SWIFT observed by HUSSEY, April 17.6710 G. M. T.; R. A. $3^h\ 37^m\ 46^s.3$; Decl. $+20°\ 55'\ 50''$. A re-reduction of the observations the next morning showed that for $46^s.3$ we should put $46^s.1$. This correction was sent to the H. C. O. on Saturday, April 18th, at $11^h\ 12^m$ A. M. The correct position had been sent to Berkeley. April 18th was cloudy.

Telegram sent Sunday, April 19th, at $10^h\ 1^m$ P. M. (translation): To H. C. O.—Comet SWIFT observed by AITKEN, April 19.6691 G. M. T.; R. A. $3^h\ 35^m\ 42^s.0$; Decl. $+26°\ 19'\ 26''$.

Telegram sent Monday, April 20th, at $12^h\ 30^m$ P. M. (translation): To H. C. O.—

Elements and Ephemeris of Comet b, 1896 (SWIFT), *computed by* ROBERT G. AITKEN (col. I).*

	I.		II.	
$T =$	1896 April 17.79 G. M. T.		April 17.65.	
$\omega =$	$2°\ 14'$	1896.0	$1°\ 45'$	1896.0
$\Omega =$	177 58		178 16	
$i =$	56 0		55 35	
$q =$	0.5645		0.5663	

The foregoing elements are from observations by Professor HUSSEY (April 16–17) and Professor AITKEN (April 19). (O—C) $\Delta\lambda \cos\beta = -5''.0$; $\Delta\beta = -4''.0$.

Ephemeris.

Greenwich Date.	R. A.	N. P. D.	Brightness.
April 20.5 . .	$3^h\ 33^m.9$	$61°\ 14'$	1.20
April 24.5 . .	3 23 .7	50 31	....
April 28.5 . .	3 7 .6	41 16	....
May 2.5 . .	2 46 .0	33 58	0.70

* Printed in the *Science Observer Circular*, No. 112, of April 21, 1896.

Telegram sent to H. C. O., Monday, April 20th, at 5^h 0^m P.M. (translation): The orbit presents some resemblance to that of the first comet of 1822.

Telegram received from Berkeley, Monday, April 20th, at 10^h 20^m P. M. (translation):

Elements of Comet b, 1896 (SWIFT), *computed by* A. O. LEUSCHNER *and* F. H. SEARES.*

[The elements as received are given in column II above, for ready comparison with those of Professor AITKEN.]

THE USE OF THE SCIENCE OBSERVER CODE IN FOREIGN COUNTRIES.

A letter just received from Professor KREUTZ, of Kiel, gives the following particulars regarding the use of the Science Observer code in the transmission of astronomical telegrams to and from the Central Bureau of Astronomical Telegrams, at Kiel:

"Telegrams from America are received by the S. O. code. Telegrams from Kiel to America, Africa, Australia, and Madras are also sent by the S. O. code. On the Continent of Europe a number-code is employed, which has worked extremely well. Five figures (as 52687) are accepted in European telegraph offices as one word. On the Atlantic cables, three figures count as one word, while throughout the United States each figure is so counted. An experience of several years has shown the number-code to be entirely satisfactory throughout the Continent, and the S. O. code is seldom or never employed."

The number-code used in Europe was explained in No. 49 of these *Publications*. It cannot be employed in the United States, on account of the expense. E. S. H.

1896, April 4.

COMET TELEGRAMS IN THE SOUTHERN HEMISPHERE.—EXTRACTS FROM THE REPORT OF MR. TEBBUTT'S OBSERVATORY FOR 1895.

"The telegrams announcing the discoveries of these comets, (the bright comets discovered by PERRINE† and BROOKS‡) were received, respectively, on November 19th and 26th, with the respective motions for the 17th and 21st, but without any indication of the direction of motion.

* Printed in the *Astronomical Journal*, No. 373, of April 30, 1896.
† Comet *c*, '95, discovered November 18.1, G. M. T., at Mt. Hamilton.
‡ Comet *d*, '95, discovered November 21.8, G. M. T., at Geneva, N. Y.

"An opportunity did not present itself till December 2d, and I then swept for BROOKS' Comet between 5° and 17° South Declination * * * * without success. On the evening of the same day, in answer to enquiries, a telegram was received from the Melbourne Observatory giving the position for November 25.644, G. M. T., from which it was quite obvious that the search was made too far south. Cloudy weather again set in and continued for some days. Towards the close of December a very brilliant comet was reported to have been seen * * * at various places in New South Wales and Victoria; * * * this brilliant object was no other than the comet discovered by PERRINE.

"It is much to be regretted that beyond the original announcement of the discovery of this comet no further particulars were cabled to Australia. Had the elements or a few ephemeris positions been furnished in time, it is probable that some positions might have been secured."

TOTAL ECLIPSE OF AUGUST, 1896—RUSSIAN PROGRAMME.

Russian astronomers are completing their arrangements for viewing the forthcoming eclipse of the Sun. The Pulkowa Observatory will send an expedition to the Lower Amur; the Academy of Sciences has chosen Novaya Zemlya for the seat of its operations; so has the Kasan Society of Naturalists; while the Geographical Society will send the Director of the Irkutsk Meteorological Observatory, A. V. VOZNESENSKY, to the Oleminsk, on the Lena, for meteorological observations. Professor GLASENAPP and L. G. VUCHIKHOVSKY propose to go to Finland on their own account. The young Russian Astronomical Society (it was founded only in 1891) directs its chief attention to physical observations, and it will have three parties of observers, provided with photographic appliances. The chief station will be on the Lena, where the duration of the eclipse is longest; and it is proposed to photograph there the corona by SCHAEBERLE'S method, with an objective of long focal length, and also to photograph, by means of two spectrographs, the spectrum of the corona, as well as the limb of the Sun, by means of a camera provided with a RUTHERFURD prism. At the second station, on the bay of the Ob, the corona will be photographed by means of several ordinary cameras; while at the third station, in the eastern part of

the Uleaborg province, to the north of Enontekis, the corona will be photographed by means of several cameras, following the movement of the Sun; and it is intended to establish a comparison between the spectrum of the corona and that of helium. The usual determinations of the duration of the eclipse will be made at the first and third stations.—*Nature*, 1896, March 26, p. 492.

ELEMENTS AND EPHEMERIS OF COMET *b* (SWIFT), 1896, BY R. G. AITKEN.

The following elements are based on Professor HUSSEY'S observations of April 16th and 17th, and my own of April 19th:

$$T = \text{G. M. T. April } 17.7934$$

$$\left.\begin{aligned} \Omega &= 177^\circ\ 58'.3 \\ i &= 56\ \ \ 0.2 \\ \omega &= 2\ \ 13.8 \end{aligned}\right\} 1896.0$$

$$q = 0.5645$$

Residuals for the middle place (O—C):

$$\Delta\lambda \cos\beta = -5''.0;\ \Delta\beta = -4''.0$$

The ephemeris is printed elsewhere.

MOUNT HAMILTON, April 20, 1896.

POINT REYES LIGHT SEEN FROM MOUNT HAMILTON.

On March 23, 1896, the atmosphere to the west being very free from smoke and dust, owing to the prevalence of south and southeast winds, Point Reyes was distinctly visible over the hills south of San Francisco. It was particularly plain about sunset. The next morning, between four and five o'clock, the light was also very plainly seen, flashing at intervals of five seconds, and was fully as noticeable as any of the brightest electric lights in San Francisco. From STIELER'S atlas it is found that the distance of Point Reyes from the LICK Observatory is about ninety-four miles. The sea horizon is eighty-seven miles distant at the altitude of the LICK Observatory.

The Pacific Ocean was also seen over two low places in the hills to the south of San Francisco. C. D. PERRINE.

March 28, 1896.

Note on the Discovery of Comet *b*, 1896.

The following extracts from Professor Lewis Swift's letters to the Lick Observatory, relating to the discovery of Comet *b*, 1896, will be of general interest:

Under date of Thursday, April 16th, he writes: "I telegraphed you this A. M. of the discovery of a comet. I ran across it while comet-seeking ten days ago; but, after watching some time and observing no motion, I pronounced it a nebula. Monday night [i. e. April 13th] I ran across it again, and my suspicion was that it might be a comet after all; but before I could find it with the large equatorial, a cloud obscured it, so I only saw it with the 4½-inch for about thirty seconds. The next night was cloudy. Last night [April 15th] I had both telescopes ready, and in bright twilight picked up the object with the 4½-inch, and soon had it in the field of the 16-inch. I immediately pronounced it a comet, which, when it grew a little darker, I saw had an excessively faint tail. From the circles I made its position $\alpha = 3^h\ 39^m$; $\delta = +\ 15°\ 40'$. It is brighter than it was ten days ago. In consequence of the absence of the telegrapher from the mountain, I was unable to telegraph last night."

On April 24th, Professor Swift writes again: "That ten days was an indefinite quantity, as, after reflection, my memory tells me it was several days previous to that that I ran across with the comet-seeker an object, pretty low down in the southwest, which greatly resembled the comet. I assumed this to be N. G. C. 1535. Soon after, I ran across a similar-appearing object, which I took to be N. G. C. 1600, and, again, another, which I thought might be N. G. C. 1453. Now, whether any one of these was the comet I am unable to affirm. My belief is that some or all were."

Professor Swift adds: "I think the date of discovery should be April 13th."

I have plotted the three nebulæ mentioned by Professor Swift, and also the path of the comet, computing its positions for April 3.5 and April 8.5, in addition to its positions since it was observed at Mount Hamilton. The chart shows that the comet passed about three degrees west of N. G. C. 1453 some time during the afternoon or evening of April 5th. It was then about one-half as bright as at the assumed date of discovery (April 13th).

The comet's nearest approach to N. G. C. 1535 was about April 1st, when it passed some twelve degrees west of it. It was at no time nearer than fourteen degrees to N. G. C. 1600.

It seems quite probable, therefore, that Professor SWIFT actually saw the comet some time about the 4th or 5th of April, mistaking it for N. G. C. 1453. R. G. AITKEN.

April 29, 1896.

PHOTOGRAPHS OF COMET PERRINE *a*, 1896.

On six mornings, those of February 18th, 19th, 20th, 22d, 23d, 25th, I secured photographs of this comet, using the large DALLMEYER portrait lens belonging to Hon. W. M. PIERSON, which I had temporarily fastened to the mounting of the six-inch equatorial telescope. The exposures varied in length from forty minutes to ninety-five minutes. All but one of the negatives showed the comet with at least a trace of a tail; in the first one taken, the tail was nearly or quite a degree long. Unfavorable conditions interrupted the series until March 9th, when, the comet having become an evening object, visible in the northwest, an exposure of three hours was secured. The resulting negative represented the comet with a tail about a degree and a half in length. No especially interesting features were detected in this series of photographs. A. L. C.

PECULIAR PHENOMENON SEEN AT VISALIA, APRIL 18, 1896.*

Yesterday, at 11:30 A. M., the attention of several people was attracted to a cloud in the southern heavens, wearing the colors of the rainbow. When first noticed, the hues were distinct and bright.

The sky at the time was partially overcast with light cirro-cumuli, traveling eastward at a low altitude. Through and above these could be plainly seen a horizontal stratum of white cloud, which exhibited the effect mentioned. In less than a minute the colors disappeared, and the cloud again became white. Twice again within fifteen minutes the peculiar change of hue was observed, but after the first time red, purple, and a light blue were the only shades that became distinct.— *From the Visalia Delta, April 19th.*

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* Communicated by GEORGE W. STEWART, Esq.

THE MANUSCRIPTS OF BESSEL.

The manuscripts of BESSEL'S communications to the *Astronomische Nachrichten*, some ninety in number, from volume II onwards, are the property of the estate of the late Professor C. F. W. PETERS. His widow, Mrs. H. PETERS (Mittletragheim, 4, IV, Koenigsberg) offers these manuscripts for sale, as Professor PETERS left no son. They have all been published, and science has nothing new to expect from them. But it may be said that modern astronomical science is built on the foundations laid down in these immortal memoirs; and, out of respect for the memory of BESSEL, it is to be hoped that his manuscripts may find a permanent home in some university or observatory library, and not be dispersed among the albums of autograph collectors. EDWARD S. HOLDEN.

1896, April 2.

A MOVABLE OBSERVATORY.

CHICAGO, May 3d.—Sixty thousand dollars have been expended on the construction and equipment of a great observatory, and a number of years of the valuable time of two noted astronomers and their assistants, will be devoted to what is expected to prove the most important astronomical expedition of the century. PERCIVAL LOWELL, of Boston, has built the observatory and great telescope, and will be one of the principal scientists on the expedition. Dr. T. J. J. SEE, of the University of Chicago, will be the other. Both are scientists of renown. Their operations will begin in July, from the movable observatory to be erected on the lofty Mexican plateau near the City of Mexico, and will probably be continued, in 1898, somewhere down in Peru.

The objects of the expedition are twofold. Mr. LOWELL will study the planet *Mars* in a systematical way that has seldom been pursued, and Dr. SEE will search the southern heavens for double stars, in the hope of doing there what BURNHAM, of Chicago, has done for the northern skies.

The observatory will have one of the most powerful telescopes in the world. The twenty-four-inch lens has just been finished by ALVAN CLARKE, the telescope-maker of Cambridgeport, Mass., and, in the test, it was shown to be superior to the twenty-six-inch glass at the Naval Observatory in Washington.—*The Chronicle*, S. F., May 4, 1896.

A Bright Meteor. (May 9, 1896.)

On May 9, 1896, I saw a very bright meteor, at $10^h\ 37^m\ 58^s \pm 5^s$ to $10^h\ 58^m\ 8^s \pm 5^s$, P. S. T. It was very near to *Altair* when first seen, and almost exactly in the direction of that star. It was visible for ten seconds, and disappeared at a point which was afterwards found from a star-chart to be R. A., $19^h\ 20^m$; Decl. $-5°$.

The meteor was five or six times as bright as *Venus*, and increased in brilliancy towards the end of its path. It was pear-shaped, and had a brilliant bluish-white nucleus, but left no train. It was not seen to burst, nor was any noise heard, although listened for, for several minutes. C. D. Perrine.

Mt. Hamilton, May 11, 1896.

Bright Meteor, May 19, 1896.

A meteor fully ten times as bright as *Venus* was seen to fall almost vertically through *Sagittarius* on the meridian of 19^h from about $-25°$ to $-45°$. It was visible for 3^s from $14^h\ 46^m\ 12^s$ P. S. T. to $14^h\ 46^m\ 15^s$ P. S. T. The haze in the sky was illuminated by the meteor and disappearance took place in a stratum of cloud near the horizon. Its color was bluish white.

C. D. Perrine.

Mt. Hamilton, May 22, 1896.

Errors in Cipher Telegrams due to the Morse-Code.

Some of the letters of the Morse-Code used by telegraphers are liable to be interchanged in transmission. General William J. Palmer, President of the Rio Grande Western Railway, kindly furnishes the accompanying list of the most common errors of the sort, as shown by his own experience.

E. S. H.

L for t, or vice versa.
Ll " m, " " "
Te " n, " " "
Le " n, " " "
C for r, or S, or vice versa.
Z " se, " " "
O " ee, or i, " " "
U " a, " " "
B " d, " " "
G " n, " " "

HONOR CONFERRED ON DR. HOLDEN.

The President of the United States has appointed the Director of the LICK Observatory to be a member of the Board of Visitors of the U. S. Naval Academy at Annapolis.

ELEMENTS OF COMET *b*, 1896 (SWIFT).

The following elements are derived from Mount Hamilton observations of April 17th (HUSSEY), April 30th (HUSSEY), and May 13th (HUSSEY and AITKEN):

$$\begin{array}{ll} T & \text{April } 17.66330 \\ \omega & 1^\circ\ 45'\ 32''.9 \\ \Omega & 178\ \ 20\ \ 14\ .9 \\ i & 55\ \ 33\ \ 53\ .8 \\ \log q & 9.753438 \end{array}$$

Residuals for the middle place:

$$\begin{array}{lll} O\text{–}C = & \Delta\lambda^1 \cos \beta^1 & -1''.7 \\ & \Delta\beta^1 & -0\ .5 \end{array}$$

C. D. PERRINE.

ERRATUM IN STAR CATALOGUE.

In *Neue Annalen der Muenchener Sternwarte*, Band I, No. 21305 is referred to as being in Schjellerup's Catalogue, but is not found there.

C. D. PERRINE.

MT. HAMILTON, May 22, 1896.

MINUTES OF THE MEETING OF THE BOARD OF DIRECTORS, HELD AT THE LICK OBSERVATORY, JUNE 13, 1896.

President HUSSEY presided. A quorum was present. The minutes of the last meeting were approved. The following members were duly elected:

LIST OF MEMBERS ELECTED JUNE 13, 1896.

Mr. C. F. DE LANDERO*	P. O. Box 1, Pachuca, State Hidalgo, Mexico.
LIBRARY OF THE OBSERVATORY	Georgetown College, D. C.
LIBRARY OF THE UNIVERSITY OF PENNSYLVANIA	Philadelphia, Pa.
LIBRARY OF YALE UNIVERSITY	New Haven, Conn.
Prof. J. M. McIVER	State Normal University, Scottsboro', Alabama.
Mr. JOHN W. STETSON	906 Broadway, Oakland, Cal.

It being announced to the Board that Professor SCHAEBERLE, one of the members of the Comet-Medal Committee, is to be absent from the State on solar eclipse work during some months of this year, it was

Resolved, That Mr. C. D. PERRINE be and he is hereby appointed a member of the Comet-Medal Committee, to act in Professor SCHAEBERLE'S place during his absence.

It was, on motion

Resolved, That the moneys belonging to the Permanent Funds of the Society, namely:

Alexander Montgomery Library Fund	$1,857 38
Donohoe Comet-Medal Fund	653 32
Life Membership Fund	1,750 61

be transferred and deposited with the following Savings Banks, namely:

Alexander Montgomery Library Fund—

With the San Francisco Savings Union	$ 641 40	
" " German Savings and Loan Society	615 98	
" " Hibernia Savings and Loan Society	600 00	
		$1,857 38

Donohoe Comet-Medal Fund—

With the San Francisco Savings Union	$ 253 32	
" " German Savings and Loan Society	200 00	
" " Hibernia Savings and Loan Society	200 00	
		$ 653 32

Life-Membership Fund—

With the San Francisco Savings Union	$ 550 61	
" " German Savings and Loan Society	600 00	
" " Hibernia Savings and Loan Society	600 00	
		$1,750 61

The Treasurer is instructed to carry out these transfers.

Resolved, That F. R. ZIEL, Treasurer of the Society, is hereby authorized to receive and receipt for moneys on deposit with the Hibernia Savings and Loan Society, and that all orders must be signed by him.

Adjourned.

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* A star signifies life membership.

Minutes of the Meeting of the Astronomical Society of the Pacific, held at the Lick Observatory, June 13, 1896.

The meeting was called to order by President Hussey. The minutes of the last meeting were approved.

The Secretary read the names of new members duly elected at the Directors' meeting.

The following papers were presented:

1. Reported Volcanic Eruptions, 1690–1895, by F. G. Plummer, of Tacoma.
2. Tables of the Elements of Comets' Orbits, B. C. 372 to A. D. 1896, by Professor Wm. C. Winlock, of Washington.
3. Planetary Phenomena for July and August, 1896, by Professor Malcolm McNeill, of Lake Forest.
4. Observations of Dark Markings on *Venus*, by Professor E. S. Holden, of Lick Observatory.
5. The Companion of *Sirius*, and its Brightness according to Photometric Theory, by Professor W. J. Hussey, of Lick Observatory.

Adjourned.

NOTICE.

The attention of new members is called to Article VIII of the By-Laws, which provides that the annual subscription, paid on election, covers the *calendar* year only Subsequent annual payments are due on January 1st of each succeeding calendar year. This rule is necessary in order to make our book-keeping as simple as possible. Dues sent by mail should be directed to Astronomical Society of the Pacific 819 Market Street, San Francisco.

It is intended that each member of the Society shall receive a copy of each one of the *Publications* for the year in which he was elected to membership and for all subsequent years. If there have been (unfortunately) any omissions in this matter, it is requested that the Secretaries be at once notified, in order that the missing numbers may be supplied. Members are requested to preserve the copies of the *Publications* of the Society as sent to them. Once each year a title-page and contents of the preceding numbers will also be sent to the members, who can then bind the numbers together into a volume. Complete volumes for past years will also be supplied, to members only, so far as the stock in hand is sufficient, on the payment of two dollars to either of the Secretaries. Any non-resident member within the United States can obtain books from the Society's library by sending his library card with ten cents in stamps to the Secretary A. S. P., 819 Market Street, San Francisco, who will return the book and the card.

The Committee on Publication desires to say that the order in which papers are printed in the *Publications* is decided simply by convenience. In a general way, those papers are printed first which are earliest accepted for publication. It is not possible to send proof sheets of papers to be printed to authors whose residence is not within the United States. The responsibility for the views expressed in the papers printed rests with the writers, and is not assumed by the Society itself.

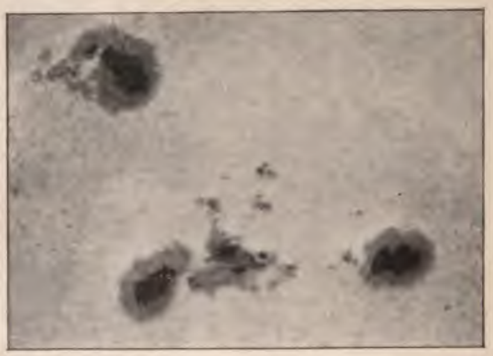
The titles of papers for reading should be communicated to either of the Secretaries as early as possible, as well as any changes in addresses. The Secretary in San Francisco will send to any member of the Society suitable stationery, stamped with the seal of the Society, at cost price, as follows: a block of letter paper, 40 cents; of note paper, 25 cents; a package of envelopes, 25 cents. These prices include postage, and should be remitted by money-order or in U. S. postage stamps. The sendings are at the risk of the member.

Those members who propose to attend the meetings at Mount Hamilton during the summer should communicate with "The Secretary Astronomical Society of the Pacific" at the rooms of the Society, 819 Market Street, San Francisco, in order that arrangements may be made for transportation, lodging, etc.

PUBLICATIONS ISSUED BI-MONTHLY.

(February, April, June, August, October, December.)

August 8, 1893.



August 31, 1893.

September 27, 1893.

SUN SPOTS. ENLARGED 3¼ DIAMETERS.

PUBLICATIONS

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PLANETARY PHENOMENA FOR SEPTEMBER AND OCTOBER, 1896.

By Professor Malcolm McNeill.

September, 1896.

The Sun crosses the equator and Autumn begins about 5 A.M., P. S. T., September 22d.

Mercury is an evening star throughout the month, and comes to greatest east elongation on the morning of September 13th; but it is also quite far south of the Sun, and the times of setting are not an hour apart. It is, therefore, not in very good position for naked-eye observation. On the afternoon of September 24th it passes a little less than five degrees south of *Venus*, but there is not much chance of seeing it except under very favorable conditions of weather.

Venus is also an evening star, setting not quite an hour after the Sun. It is so much brighter than *Mercury*, that there will be no great difficulty in seeing it. On September 23d it passes about three degrees north of the first-magnitude star *Spica* (α *Virginis*), and *Mercury* is at the same time quite near, two degrees south of *Spica*.

Mars is beginning to get into position for evening observation. By the end of the month it rises before 9:30. It is moving rapidly eastward through *Taurus* from a position about four degrees north of the first-magnitude red star *Aldebaran* (α *Tauri*), on September 1st, to the eastern part of the constellation, on September 30th, about fifteen degrees in all. On September 1st it is distant from the Earth about the mean distance of the Earth

from the Sun, ninety-three millions of miles, and at the end of the month it is less than eighty. It is beginning to be much brighter than before, and has become quite a conspicuous object.

Jupiter is a morning star rising more than an hour before the Sun on September 1st, and more than three hours before on September 30th. During the month it moves about six degrees eastward and southward in the constellation *Leo*, and it is quite near the first-magnitude star *Regulus* (α *Leonis*). On the morning of September 19th it passes about twenty minutes, two-thirds of the Moon's apparent diameter, north of the star.

Saturn is still an evening star, setting about two hours earlier than at the corresponding date in August. It moves about three degrees eastward and southward in the constellation *Libra*, and is a little east and south of the principal star of the constellation, α *Libræ*. The rings are apparently a little wider open than in August.

Uranus follows after *Saturn* about five degrees east and three degrees south. It is so low down after sunset that it will not be easy to see, unless in very clear weather.

Neptune is in the constellation *Taurus* in the neighborhood of *Mars*. *Mars* passes about one degree north of it on the morning of September 24th.

OCTOBER, 1896.

Occultations. The Moon passes over the group of the *Pleiades* on the evening of October 23d, and many occultations can be seen from almost any part of the United States, although the eastern part of the country is perhaps a little better situated for observation. The Moon is only two days past full, and the immersions will come at the bright limb, and the emersions at the dark limb.

Mercury passes inferior conjunction with the Sun, and changes from an evening to a morning star, on the afternoon of October 8th. Its apparent distance from the Sun rapidly increases, and it comes to greatest west elongation on the morning of October 24th. From October 20th to the end of the month, it rises nearly an hour and a half before the Sun, and is in pretty good position for observation. At the close of the month it is again near the first-magnitude star *Spica*, about four degrees to the north. The date of nearest approach is October 30th.

Venus is evening star, and sets an hour and one-half later than the Sun at the close of the month. On the afternoon of

October 15th it passes a little more than two degrees south of *Saturn*. It is growing a little brighter, but is not nearly as conspicuous as it is when it is between greatest elongation and inferior conjunction.

Mars rises before 8 P.M. at the close of the month. It is still moving eastward among the stars, but is gradually slowing up, and on November 1st it becomes stationary, ready to begin its westward motion, which it will keep up until after opposition. After the first of the month it is in the western part of the constellation *Gemini*. The distance from the Earth is diminishing rapidly, and at the end of the month it is only a little more than sixty millions of miles, about ten millions greater than it will be at opposition in December. The distance at opposition is considerably greater than during the last two oppositions.

Jupiter is rising earlier, only a little after 1 A.M. at the close of the month. It moves five degrees eastward and southward during the month, and is in the constellation *Leo*.

Saturn is too close to the Sun for good observation. At the end of the month it sets only a little more than half an hour after sunset, and it will be scarcely possible to see it with the naked eye. It will come to conjunction in the middle of November.

Uranus is about four degrees east and south of *Saturn*, and sets only a few minutes later. It is too close to the horizon after sunset to be seen without a telescope.

Neptune rises at about 8 P.M. in the middle of the month. It is in the eastern part of the constellation *Taurus*.

Explanation of the Tables.

The phases of the Moon are given in Pacific Standard time. In the tables for Sun and planets, the second and third columns give the Right Ascension and Declination for Greenwich noon. The fifth column gives the local mean time for transit over the Greenwich meridian. To find the local mean time of transit for any other meridian, the time given in the table must be corrected by adding or subtracting the change per day, multiplied by the fraction whose numerator is the longitude from Greenwich in hours, and whose denominator is 24. This correction is seldom much more than 1^m. To find the standard time for the phenomenon, correct the local mean time by *adding* the difference between standard and local time if the place is west of the standard meridian, and *subtracting* if east. The same rules apply

to the fourth and sixth columns, which give the local mean tim of rising and setting for the meridian of Greenwich. They a roughly computed for Lat. 40°, with the noon Declination a time of meridian transit, and are intended as only a rough guic They may be in error by a minute or two for the given latituc and for latitudes differing much from 40° they may be seve minutes out.

PHASES OF THE MOON, P. S. T.

		H. M.
New Moon,	Sept. 7,	5 43 A. M.
First Quarter,	Sept. 13,	8 9 P. M.
Full Moon,	Sept. 21,	2 49 P. M.
Last Quarter,	Sept. 29,	5 58 P. M.

THE SUN.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Sept. 1.	10 44	+ 8 0	5 33 A.M.	12 0	6 27 P.
11.	11 20	+ 4 16	5 42	11 56 A.M.	6 10
21.	11 56	+ 0 24	5 52	11 53	5 54
Oct. 1.	12 32	− 3 29	6 0	11 49	5 38

MERCURY.

Sept. 1.	12 12	− 2 19	7 35 A.M.	1 27 P.M.	7 19 P.
11.	12 54	− 8 23	7 59	1 30	7 1
21.	13 22	− 12 27	8 2	1 19	6 36
Oct. 1.	13 21	− 12 20	7 20	12 38	5 56

VENUS.

Sept. 1.	11 41	+ 3 27	6 46 A.M.	12 57 P.M.	7 8 P.
11.	12 26	− 1 40	7 8	1 2	6 56
21.	13 11	− 6 46	7 31	1 8	6 45
Oct. 1.	13 57	− 11 38	7 54	1 14	6 34

MARS.

Sept. 1.	4 32	+ 20 48	10 33 P.M.	5 47 A.M.	1 1 P.
11.	4 53	+ 21 41	10 12	5 30	12 48
21.	5 13	+ 22 21	9 49	5 10	12 31
Oct. 1.	5 30	+ 22 53	9 25	4 48	12 11

Jupiter.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Sept. 1.	9 48	+14 5	4 16 A.M.	11 4 A.M.	5 52 P.M.
11.	9 56	+13 23	3 46	10 32	5 18
21.	10 4	+12 41	3 18	10 1	4 44
Oct. 1.	10 12	+12 1	2 48	9 29	4 10

Saturn.

Sept. 1.	14 50	−14 4	10 52 A.M.	4 4 P.M.	9 16 P.M.
11.	14 53	−14 20	10 17	3 28	8 39
21.	14 56	−14 37	9 42	2 52	8 2
Oct. 1.	15 0	−14 55	9 9	2 17	7 25

Uranus.

Sept. 1.	15 14	−17 45	11 31 A.M.	4 29 P.M.	9 27 P.M.
11.	15 16	−17 51	10 53	3 51	8 49
21.	15 17	−17 57	10 16	3 13	8 10
Oct. 1.	15 19	−18 5	9 39	2 36	7 33

Neptune.

Sept. 1.	5 18	+21 42	11 15 P.M.	6 33 A.M.	1 51 P.M.
11.	5 18	+21 42	10 37	5 55	1 13
21.	5 18	+21 41	9 58	5 16	12 34
Oct. 1.	5 18	+21 41	9 19	4 37	11 55 A.M.

Phases of the Moon, P. S. T.

		H. M.
New Moon,	Oct. 6,	2 18 P. M.
First Quarter,	Oct. 13,	6 47 A. M.
Full Moon,	Oct. 21,	8 17 A. M.
Last Quarter,	Oct. 29,	7 21 A. M.

The Sun.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Oct. 1.	12 32	− 3 29	6 0 A.M.	11 49 A.M.	5 38 P.M.
11.	13 9	− 7 19	6 12	11 47	5 22
21.	13 46	−10 59	6 23	11 45	5 7
31.	14 25	−14 22	6 34	11 44	4 54

Mercury.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Oct. 1.	13 21	− 12 20	7 20 A.M.	12 38 P.M.	5 56 P.M.
11.	12 47	− 6 2	5 44	11 24 A.M.	5 4
21.	12 42	− 2 42	4 50	10 41	4 32
31.	13 25	− 6 46	5 5	10 44	4 23

Venus.

Oct. 1.	13 57	− 11 38	7 54 A.M.	1 14 P.M.	6 34 P.M.
11.	14 45	− 16 3	8 19	1 23	6 27
21.	15 34	− 19 49	8 42	1 32	6 22
31.	16 26	− 22 43	9 6	1 45	6 24

Mars.

Oct. 1.	5 30	+ 22 53	9 25 P.M.	4 48 A.M.	12 11 P.M.
11.	5 44	+ 23 19	8 58	4 22	11 46 A.M.
21.	5 53	+ 23 44	8 27	3 53	11 19
31.	5 57	+ 24 10	7 50	3 18	10 46

Jupiter.

Oct. 1.	10 12	+ 12 1	2 48 A.M.	9 29 A.M.	4 10 P.M.
11.	10 19	+ 11 22	2 18	8 57	3 36
21.	10 26	+ 10 46	1 47	8 24	3 1
31.	10 32	+ 10 13	1 16	7 51	2 26

Saturn.

Oct. 1.	15 0	− 14 55	9 9 A.M.	2 17 P.M.	7 25 P.M.
11.	15 4	− 15 14	8 35	1 42	6 49
21.	15 9	− 15 33	8 1	1 7	6 13
31.	15 13	− 15 53	7 28	12 32	5 36

Uranus.

Oct. 1.	15 19	− 18 5	9 39 A.M.	2 36 P.M.	7 33 P.M.
11.	15 21	− 18 13	9 3	1 59	6 55
21.	15 24	− 18 21	8 26	1 22	6 18
31.	15 26	− 18 30	7 50	12 45	5 40

NEPTUNE.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Oct. 1.	5 18	+21 41	9 19 P.M.	4 37 A.M.	11 55 A.M.
11.	5 18	+21 40	8 39	3 57	11 15
21.	5 17	+21 39	7 59	3 17	10 35
31.	5 17	+21 38	7 19	2 37	9 55

MARS, BY PERCIVAL LOWELL.

By W. W. CAMPBELL.

Boston: Houghton, Mifflin & Co., 1895; 8vo, pp. 228 + VIII, XXIV Illustrations.

[Reprinted from the original in *Science*.]

I am pleased to comply with the Editor's request for a review of Mr. LOWELL's interesting book.

The reviewer of a work on organic evolution would find it difficult to avoid mentioning DARWIN. SCHIAPARELLI holds a similar place in the literature of *Mars*. An intelligent criticism of any recent book on *Mars* must consist largely of a review of SCHIAPARELLI'S observations and ideas. Of his predecessors it will be well to mention, for the benefit of non-astronomical readers, the following: (*a*) GALILEO (1610), who discovered the phases of the planet, thereby proving that its light, though very red, is really reflected sunlight; (*b*) HUYGHENS (1659), who first observed markings on the surface; (*c*) CASSINI (1666), who determined the length of the Martian day, and discovered the white polar caps; (*d*) Sir WM. HERSCHEL (1783), who observed the waxing and waning of the polar caps with the seasons; (*e*) BEER and MAEDLER, who published the first map of the planet's surface features, and discovered at least three of the so-called canals; (*f*) DAWES (1864), whose drawings show a dozen of the canals; and (*g*) HALL (1877), who discovered the two satellites.

SCHIAPARELLI'S work extends continuously from 1877 on. It is impossible to do justice to his labors in this article. He extended our knowledge of the planet enormously in nearly every line—in reference to the polar caps, the so-called seas and con-

tinents, but especially in reference to the so-called canals, their appearance and disappearance, their doubling, etc. His entire work bears the impress of a scientific spirit *par excellence.* His observations cover the period 1877–92, but his technical results are comprised in a few papers, and a dozen octavo pages suffice for a masterly popular exposition of his general results. His brief papers contain at least the suggestion of all the theories recently exploited by popular writers, though he was not concerned with establishing a theory, but rather with ascertaining facts.

SCHIAPARELLI'S remarkable observations of the network of straight canals and their doubling were questioned for years, but the confirmation they finally received at Nice and elsewhere largely removed the doubt.

Mr. LOWELL'S book on *Mars* is based upon the Flagstaff (Arizona) observations made by himself between May 31 and November 20, 1894, and by Professor W. H. PICKERING and Mr. A. E. DOUGLASS between May, 1894, and April, 1895. Mr. LOWELL delivered a lecture under the auspices of the Boston Scientific Society on May 22, 1894, in which he is reported (*Boston Commonwealth* for May 24, 1894) to have announced that his observatory — not yet completed — was for the purpose of making "an investigation into the conditions of life in other worlds, including last but not least their habitability by beings like or unlike man. This is not the chimerical search some may suppose. On the contrary, there is strong reason to believe that we are on the eve of pretty definite discovery in the matter."

Speaking of SCHIAPARELLI'S canals on *Mars*, Mr. LOWELL is reported to have said in his lecture, "The most self-evident explanation from the markings [canals] themselves is probably the true one; namely, that in them we are looking upon the result of the work of some sort of intelligent beings. * * * the amazing blue network on *Mars* hints that one planet besides our own is actually inhabited now. * * * we stand upon the threshold of a knowledge of our closest of kin in the world of space, of the most important character."

Mr. LOWELL went direct from the lecture-hall to his observatory in Arizona; and how well his observations established his pre-observational views is told in his book. In outline, his conclusion is that there is a scarcity of water on *Mars;* that the melting of the polar snows is the source of water supply for the planet; that a network of straight canals conducts the water from

the poles over the planet; that what we see and call canals are not water, but vegetation along the banks — a suggestion made several years ago by SCHIAPARELLI and by Professor PICKERING; that since the canals are all straight, *i. e.*, run on great circles, and are of uniform width, and in general several of them intersect in one point, then they probably are the handiwork of the Martian inhabitants; that the planet is probably inhabited by highly intelligent beings; and that the irrigation problem is their chief concern.

It will be seen that Mr. LOWELL'S results agree perfectly with his pre-observational views quoted above; but in justice to him it must be said that he has written vigorously and at length (pp. 158–161) of the dangers of bias on the part of those having preconceived notions, and in numerous paragraphs throughout the book severely criticises those who write on the subject without having made the observations. So I suppose we shall have to forget his remarkable preliminary lecture.

Before examining Mr. LOWELL'S evidences of intelligent beings on *Mars*, let us look at his idea of how the world would receive such a discovery. He believes the world would not welcome it. "To be shy of anything resembling himself is part and parcel of man's own individuality. * * * the civilized thinker instinctively turns from the thought of mind other than the one he knows." Various astounding hypotheses "commend themselves to man, if only by such means he may escape the admission of anything approaching his kind. * * * It is simply an instinct, like any other, the projection of the instinct of self-preservation."

Here Mr. LOWELL is certainly wrong. In my opinion he has taken the popular side of the most popular scientific question afloat. The world at large is anxious for the discovery of intelligent life on *Mars*, and every advocate gets an instant and large audience. Scientific men are quite ready to admit the possibility of life wherever the environment is shown to be suitable. While we can safely say that other suns than ours have their planets, and some of those planets probably support life, yet only two cases have come under satisfactory observations; the Earth and the Moon. The former is inhabited; we may safely say the latter is not. In size certainly, and in physical condition probably, *Mars* is somewhat nearer the Moon than the Earth; and while the affirmative side of the question, "Is *Mars* inhabited?" will get

at least a just hearing, those who advocate that side must prepare the burden of proof.

Speaking of the melting of the northern polar cap of *Mars*, SCHIAPARELLI wrote in 1892, "From this arises a singular phenomenon which has no analogy upon the Earth. At the melting of the snows, accumulated at that pole during the long night of ten months or more, the liquid mass produced in that operation is diffused around the circumference of the snowy region, converting a large zone of surrounding land into a temporary sea, and filling all the lower regions. This produces a gigantic inundation * * * the white spot of snow is surrounded by a dark zone, which follows its perimeter in its progressive diminution, upon a circumference ever more and more narrow. The outer part of this zone branches out into dark lines, which occupy all the surrounding region, and seem to be distributary canals, by which the liquid mass may return to its natural position. This produces in these regions very extensive lakes. * * * This inundation is spread out to a great distance by means of a network of canals, perhaps constituting the principal mechanism (if not the only one) by which water (and with it organic life) may be diffused over the arid surface of the planet; because on *Mars* it rains very rarely, and perhaps even does not rain at all. * * * Such a state of things does not cease until the snow, reduced to a minimum area, ceases to melt. Then the breadth of the canals diminishes, the temporary sea disappears, and the yellow region again returns to its former condition. The different phases of these vast phenomena are renewed at each return of the seasons, and we have been able to observe them in all their particulars very easily during the oppositions of 1882, 1884, 1886, when the planet presented its northern pole to terrestrial spectators. The most natural and most simple interpretation is that to which we have referred, of a great inundation produced by the melting of the snows. * * * We conclude therefore that the canals are such in fact, and not only in name; * * * that the lines called canals are truly great furrows or depressions in the surface of the planet, destined for the passage of the liquid mass, and constituting for it a true hydrographic system."*

At the 1894 opposition, the axis of *Mars* was tilted so that the

* For this and other passages from SCHIAPARELLI's Italian papers, I am indebted to Professor PICKERING's translation in *Astronomy and Astro-Physics*, 1894.

region between the south pole and forty degrees north latitude was presented to terrestrial observers, the north polar region being hidden from sight. Mr. LOWELL'S observations covered one-fourth of the Martian year, from May 1st to August 1st, Martian time. His book pays special attention to the melting of the south polar cap, and to what he considers to be the train of related phenomena; since around and upon those phenomena he builds his argument for intelligent life on that planet. On May 1st, Martian time, the south cap was "in rapid process of melting. * * * As it melted, a dark band appeared surrounding it on all sides. Except, as I have since learned, at Arequipa, this band has never, I believe, been distinctively noted or commented on before, which is singular, considering how conspicuous it was at Flagstaff." (This last sentence is indeed surprising, as scores of drawings published in 1892 and earlier show this dark band very conspicuously; it is well known to all observers of *Mars*, and SCHIAPARELLI'S description of the same phenomena at the melting of the north polar cap is very familiar.) "As the snows dwindled, the blue band shrunk in width to correspond," and finally when the cap had entirely disappeared, its encircling dark band had also vanished. Mr. LOWELL believes the dark band was water, and that it disappeared by flowing away from the pole toward the equator in canals, circulating through the planet's arid regions. In proof thereof he submits that he has observed a slow wave of dark area to advance equator-ward from the poles; that the canals nearest the south pole grew dark, and thereby became visible first; then those nearer the equator; then those at the equator; and finally those north of the equator; in other words, in the order that water flowing from the south pole would reach different parts of the planet.

It will be seen that the Flagstaff observations upon the melting of the south polar cap and the flow of water therefrom are identical with those made (and published) by SCHIAPARELLI in the case of the north polar cap in 1882, 1884, 1886; but these observations by SCHIAPARELLI are not mentioned in Mr. LOWELL'S book. The Flagstaff observations in a measure confirm SCHIAPARELLI'S general results, and extend them to the region of the south pole.

Of the origin of the canal system, SCHIAPARELLI writes entertainingly: "Their singular aspect, and their being drawn with absolute geometrical precision, as if they were the work of

rule or compass, has led some to see in them the work of intelligent beings, inhabitants of the planet. I am very careful not to combat this theory, which includes nothing impossible. * * * The network formed by these was probably determined in its origin in the geological state of the planet, and has come to be slowly elaborated in the course of centuries. It is not necessary to suppose them the work of intelligent beings, and notwithstanding the almost geometrical appearance of all of their system, we are now inclined to believe them to be produced by the evolution of the planet, just as on the Earth we have the English Channel and the Channel of Mozambique."

Of the gemination of the canals, SCHIAPARELLI writes: "In consequence of a rapid process, which certainly lasts at most a few days, or even perhaps only a few hours, * * * a given canal changes its appearance, and is found transformed through all its length into two lines or uniform stripes, more or less parallel to one another, and which run straight and equal with the exact geometrical precision of the rails of a railroad. * * * One of these is often superposed as exactly as possible upon the former line, the other being drawn anew. * * * But it also happens that both the lines may occupy opposite sides of the former canal, and be located upon entirely new ground. The distance between the two lines differs in different geminations, and varies from 360 miles and more, down to the smallest limit at which two lines may appear separated in large visual telescopes—less than an interval of thirty miles." SCHIAPARELLI explains that the variations might be the result of "extensive agricultural labor and irrigation upon a large scale. Let us add further that the intervention of intelligent beings might explain the geometrical appearance of the gemination, but it is not at all necessary for such a purpose. The geometry of nature is manifested in many other facts, from which are excluded the idea of any artificial labor whatever. * * * It would be far more easy if we were willing to introduce the forces pertaining to organic nature. Here the field of plausible supposition is immense, being capable of making an infinite number of combinations, capable of satisfying the appearances even with the smallest and simplest means. Changes of vegetation over a vast area * * * may well be rendered visible at such a distance. * * * For us, who know so little of the physical state of *Mars*, and nothing of its organic life, the great liberty of possible supposition renders arbitrary all

explanations of this sort, and constitutes the gravest obstacle to the acquisition of well-founded notions."

Such, in effect, is all that SCHIAPARELLI has written by way of explanation of his remarkable discoveries, and he who runs may read his scientific mind.

Mr. LOWELL'S book contains a beautiful map of the portion of *Mars* lying between seventy south and forty north latitude (on Mercator's projection). It represents the *ensemble* of the individual sketches made by Messrs. LOWELL, PICKERING, and DOUGLASS at Flagstaff in November, 1894. It contains 183 canals, lying both in the light and dark regions of the planet. Of those lying in the light reddish region, sixty-seven appear to be identical with those discovered by SCHIAPARELLI and his predecessors, and seventy-two appear to be new. Mr. DOUGLASS is credited with the discovery of forty-four canals in the dark regions of the planet. I infer from Mr. LOWELL'S book that the canals in the dark regions were not seen and confirmed by either Mr. LOWELL or Professor PICKERING, though they were observing *Mars* at the same time and place. Evidently, then, these observations at Flagstaff were difficult, and Mr. LOWELL considers them to be new, though they are not new. In 1892 Professor SCHAEBERLE observed them, and wrote that "Crossing the darker areas are still darker streaks which often extend hundreds of miles in nearly straight lines. One end of a given streak usually terminates in the equatorial region at a point where the dark area protrudes into the bright area, and the so-called canals seem to be continuations of the streaks." (*Publications* A. S. P., IV, 197). It was often noticed in 1894 by the writer and other LICK observers that the dark areas on *Mars* were composed of a mass of details so complex as to defy the draughtsman's skill; but I think Mr. DOUGLASS at Flagstaff is the only observer who has verified Professor SCHAEBERLE'S 1892 observations, that these markings were arranged in nearly straight lines. If the observations by Messrs. SCHAEBERLE and DOUGLASS are to extend the canal system over the dark areas, just as SCHIAPARELLI'S extend them over the bright areas, they constitute the most important recent advance in Martian work. The recent observations of canals or other details within the dark areas, the recent spectroscopic and polariscopic observations, all strongly oppose the favorite theory that the dark areas are seas, but support the common theory that the bright areas are land.

Mr. LOWELL observed a few double canals—probably a fourth as many as SCHIAPARELLI saw.

At the exact point where two or more canals cross each other, the observers noticed that there was, in nearly every case, a dark circle or oval spot, acting as the hub from which the canals radiated as spokes. To these swollen junctions Mr. LOWELL applies the name "oases." A few of these spots were observed by SCHIAPARELLI and others, but the Flagstaff observers have greatly extended the list.

As explained above, Mr. LOWELL accepts the suggestion made by SCHIAPARELLI and others that the canals form the planet's hydrographic system; that the changes observed may be due to vegetation, to irrigation on a large scale. He holds that the *visible* canals and the "oases" are due to vegetation along the lines of the *real* canals; and that the whole system essentially proves, or at least renders it very probable, that *Mars* is inhabited by a highly intelligent race whose chief concern is irrigation. His argument is made with great skill. Every fact is considered to point in that direction, and every observed phenomenon is considered to be accounted for, though in explaining the mysterious doubling of the canals he admits that "we are here very much in the dark." It is held that the canals being vegetal in character, and watered from the melting snow at the poles, are seasonal, developing in the order of their distance (in time) from the poles, and reach their highest development at or shortly after the time of summer solstice. Such, in fact, is the train of phenomena which Mr. LOWELL claims to have observed, starting from the south pole and extending to about forty degrees north latitude. SCHIAPARELLI observed similar phenomena in the vicinity of the north pole, when that region was in position for observation. His sketches, made at or shortly after the northern summer solstice, cover the region from the north pole to about forty degrees south latitude.

Let us examine Mr. LOWELL's irrigation scheme. A hydraulic engineer would ask some questions which Mr. LOWELL does not discuss in his book. In the southern summer Mr. LOWELL has the planet's surface covered with canals running in every direction, from the south pole to at least forty-three degrees north latitude, as far as the tilted position of *Mars* permitted him to see. We do not know but that they extended entirely to the north pole. In the northern summer SCHIAPARELLI's system of

canals extended from the north pole southward to thirty degrees south latitude, or further; in fact, as far as the position of the planet permitted him to observe them. And it is agreed by Mr. LOWELL that his principal canals are identical with SCHIAPARELLI'S. So we are asked to believe that the equatorial region of *Mars*, forming a strip at least seventy degrees wide, can be and is irrigated from both the north and south poles; the "canals" in the two cases of opposite flow being identical! The corresponding problem on the Earth would be to irrigate San Francisco, Chicago, New York, Rome, Tokyo, from the snow melting at the South Pole; and to irrigate Valparaiso, Cape of Good Hope, Australia, from the snow melting at our North Pole; all the irrigated land lying between New York, etc., on the north and the Cape of Good Hope, etc., on the south, to be irrigated alike from the North and South Poles. Mr. LOWELL ventures no explanation of how this engineering problem is to be worked out, though he does state that the canals form a system "precisely counterparting what a system of irrigation would look like; and, lastly, that there is a set of spots placed where we should expect to find the land thus artificially fertilized, and behaving as such constructed oases should."

If the visible canals are due to irrigated vegetation in strips thirty to sixty and more miles wide, traversing the planet's surface in straight lines in every direction, all the canals hundreds and many of them thousands of miles long, from four to ten canals radiating from a common point, intersecting at all angles a great many other canals radiating from other centers,—how is the water distributed over this large and complex area? It starts from the polar snows, we are told, and flows thousands of miles to and beyond the torrid zone, spreading in a general way over the whole planet. Do these streams lie in the valleys, or on the slopes and ridges? There is no evidence whatever that the surface is remarkably level. The canals, apparently, do not turn aside from anything. The path of least resistance seems to be unknown.

The crater *Tycho*, on our Moon, is the center of a system of markings radiating in all directions, in straight lines, hundreds and thousands of miles. They cross hills and valleys with perfect indifference. Because they are straight, and radiate from a center, did they have an intelligent personal origin?

Is a seasonal change on *Mars* evidence of an intelligent population? The virgin forests and prairies of America donned and doffed their annual green suit even better before the advent of man than to-day.

The organic origin of the dark areas on *Mars* has great advantages, as SCHIAPARELLI said; but the addition of intelligent beings to the hypothesis adds to, rather than removes, the difficulties, and leads to pure speculation. If we attempt an explanation of the irrigation system, we can, in our dilemma, only say that the Martians are more intelligent than we are!

The most striking feature of the Flagstaff observations relates to the detection of a large number of canals and "oases." It is a question how far these observations have had confirmation, and how far they need it. The observations of forty-four canals in the dark areas by Mr. DOUGLASS confirm Professor SCHAEBERLE'S 1892 observations, but they were evidently not seen by Messrs. LOWELL and PICKERING.

Mr. LOWELL gives a long list of canals in the bright areas, but it is uncertain whether or not they were seen by more than one observer. His list contains nine canals that were seen on only one occasion; they are drawn on the final map and given names. His list contains one canal that *was not seen at all*, but on *one* occasion was *suspected*; it is put on the map and given a name.

Mr. LOWELL accepts the line of reasoning put forth by PROCTOR and others as to the extent of *Mars'* atmosphere, viz.: that the mass of terrestrial atmosphere is to the mass of Mars' atmosphere as the mass of the Earth is to the mass of Mars; which leads to the result that the density of the atmosphere at the surface of Mars is about half the density of our atmosphere at the summit of the Himalayas. This is in complete harmony with the LICK spectroscopic results of 1894, which pointed to that density as the maximum limit, but is quite out of harmony with the earlier spectroscopic results.

It is well known that the atmosphere of *Mars* is practically cloudless. There is some evidence of clouds near the terminator (sunrise and sunset line), and some in favor of occasional small clouds over the portions fully exposed to the Sun's light and heat. For two or three weeks in October, 1894, all the surface features were partially obscured and rendered indistinct, as if by a general haziness, after which they again became distinct. Mr. LOWELL

believes that the Flagstaff observers saw several hundred clouds near the terminator, though he makes no use of them in explaining *Mars*' hydrographic system. They are not needed for irrigation purposes. The atmosphere is supposed to be very rarified, the polar snows melt, and the water in some manner evaporates into the atmosphere to form the polar caps by precipitation the following winter. If snow is precipitated at the cold poles, why should not rain be precipitated in the warmer regions? If the atmosphere is thin and takes up the evaporated water in a clear noon sky, why should not the rarified atmosphere cool rapidly at night and rain be precipitated, especially in the valleys? If the atmospheric circulation is slow, as it is supposed to be, the visible effects of night rains could well progress from the poles toward the equator, through the valleys, and a delicate system of surface levels would not have to be provided. This is not put forth as a theory of the canal system, except to emphasize the fact that we should give Nature a chance to do this work before we resort to artificial irrigation.

In 1890, there began at Mount Hamilton a new class of observations on *Mars*, relating to the bright projections on the terminator. Similar observations were made in 1892 and 1894. There is no doubt that they are very important, and great stress was laid on them. There are some arguments in favor of their being clouds, but many more in favor of their being mountains. The observed phenomena are fully explained by supposing a mountain chain to lie across the terminator and to disappear from sight by the planet's diurnal rotation. The observed projections were such as would be produced by the Sun shining on the mountain tops outside the terminator, and the observed adjacent depressions were such as would be formed by the shadow of the mountain range lying within the terminator. Concerning the 1894 Flagstaff observations of the terminator by Mr. DOUGLASS, Mr. LOWELL writes that "Of the 736 irregularities observed, 694 were not only recorded, but measured. Of these, 403 were depressions. It is singular, in view of their easy visibility, that, with the exception of SCHROETER, in the last century, no one should have noticed them before."

Mr. LOWELL rejects 346 out of 403 depressions as not real, since they lay on the dark areas of the planet and were due to the smaller irradiation at those places. He holds that the remaining 57 depressions were due to clouds within the terminator, and

the 291 projections were clouds outside the terminator; because if they were mountains, the number of depressions should equal the number of projections. To my mind the argument is not convincing. If we remove 196 of the projections which are described as "long and low," and which some experience in observing them leads me to ascribe to excessive irradiation, we shall have left 95 projections and 57 depressions of the "short and sharp variety." When we consider that these clouds or mountains (or something else) are immersed in an illuminated atmosphere, we cannot expect the projections and depressions to be equal in number. The problem will not be settled until it is determined whether or not the projections occupy fixed and the same positions at many successive oppositions—the phase and atmospheric conditions being equal.

I confess my inability to unravel Mr. LOWELL's discussions of Mr. DOUGLASS's observations. When it was a question of detecting a twilight effect, it was the illuminated atmosphere which formed the visible and measurable terminator. When it was a question of proving that *Mars* was extremely level, and would therefore lend itself to general irrigation, it was the land surface that formed the visible terminator; and since this terminator was always "comparatively smooth, * * * we know that, relatively to his size, he has no elevations or depressions on his surface comparable to the lunar peaks and craters." Lastly, the several hundred irregularities observed on the terminator, varying from those extremely high to those very low, were attributed to clouds. The terminator, then, is formed by the illuminated atmosphere, and not by the land surface; secondly, there are no significant elevations and depressions on the surface because the terminator, formed by the land surface, is comparatively smooth; and thirdly, the extensive irregularities on the terminator, which "may be seen every night," are due to clouds.

Mr. LOWELL writes of the "long and low" irregularities, that the projections averaged $0''.136$ in height; the depressions, $0''.125$ in depth. These are the distances from the approximately elliptic arc that would have formed the apparent terminator if the irregularities had not existed. Thus we have the heights of the irregularities from a curve that did not exist given to three decimals of a second of arc! And there is nothing to show that the varying distances of the planet were taken into account, either. Every practical astronomer knows that the *first* decimal

place is uncertain; the systematic errors in such cases can easily and generally do exceed a tenth of a second. To say that the results are accurate because they are the mean of a large number of observations, is to say that if a stranger to Colorado's clear atmosphere should waken unexpectedly on Pike's Peak and guess the distances to several hundred neighboring peaks, the mean of all the guesses would be very near the average distance.

There is not much demand for mathematical analysis in a popular book on *Mars*, nor is the application of that little always happy. On pages 133–134, after stating that practically all the canals follow the arcs of great circles, and necessarily appear curved when viewed obliquely, the author writes: "Apparent straightness throughout is only possible in comparatively short lines. For a very long arc [of a great circle] upon the surface of a revolving globe tilted toward the observer, to appear straight in its entirety, it must lie due north and south." This is incorrect. If the apparent center of the planet's disc is at eighteen degrees south latitude, which was the average for *Mars* in 1894, then every arc of every great circle that can be drawn in any direction through any point that lies on the minus eighteen degree circle of latitude will appear straight twice every day. An infinite number of such circles can be drawn.

Mr. LOWELL found that the surface markings on *Mars* came to the central meridian about twenty minutes later than the predicted time; a discrepancy, it should be said, to which Professor KEELER called special attention in 1892.

To what extent Mr. LOWELL's future observations will modify his map is uncertain. Drawings of *Mars* by different observers, even on the same night and with the same telescope, are proverbially different. So far as the drawings by the three Flagstaff observers have been published, the proverb still seems to be in force.

Mr. LOWELL is entitled to great credit for devoting his private means so generously to establishing and conducting an observatory, and for his efforts in search of the best, but imperfect, atmospheric conditions. He is likewise fully aware of the necessity of making the observations continuously and systematically. Whatever advances Mr. LOWELL may have made in Martian study, or may make in the future, will be fully accredited to him, and warmly welcomed by all astronomers.

Mr. LOWELL's book is written in a lively and entertaining

style, and is printed and illustrated faultlessly. It is true that the theories advanced are mostly old ones, suggested by SCHIAPARELLI, PICKERING, and others, many of them having been elaborated by FLAMMARION and others; but Mr. LOWELL has presented them very fully and suggestively. Scientifically, the leading faults of the book are: first, that so elaborate an argument for intelligent life on the planet, embracing a complex system of seasonal changes, should be based upon observations covering only one-fourth of only one Martian year; and second, that there should be so many evidences of apparent lack of familiarity with the literature of the subject.

LICK Observatory, University of California.

"*NOVA*," Z *CENTAURI* AND THE NEBULA SURROUNDING IT.

By WILLIAM J. HUSSEY.

Last December a "new" star, very near the bright nebula N. G. C. 5253, in the constellation *Centaurus* was announced by the Harvard College Observatory in their Circular No. 4, as having been discovered by Mrs. FLEMMING from an examination of the Draper Memorial photographs taken at Arequipa, Peru.

The Circular states that no trace of this star can be found on fifty-five plates taken from May 21, 1889, to June 14, 1895, inclusive; that it appears as 7.2 magnitude on the plates of July 8 and 10, 1895, and as 10.9 on one of December 16, 1895; that, on December 19th, it was estimated at eleventh magnitude by Mr. WENDELL, with the fifteen-inch equatorial at Cambridge.

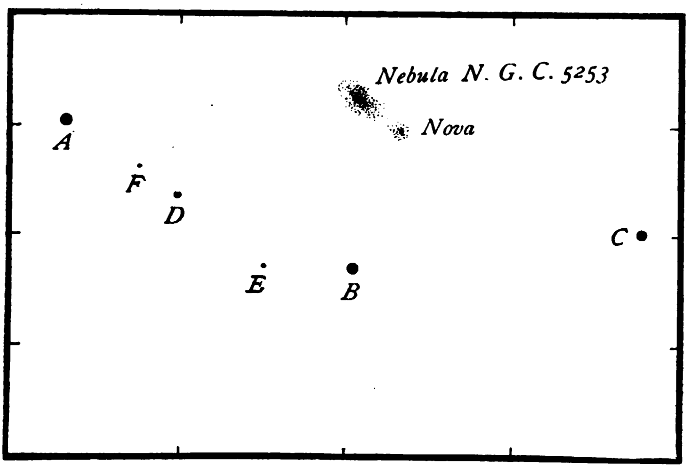
The Circular says: "The spectrum is unlike those of the new stars in *Auriga*, *Norma* and *Carina*, yet this object is like them in other respects. All were very faint or invisible for several years preceding their first known appearance. They suddenly attained their full brightness and soon began to fade."

In the *Cordoba Durchmusterung* there is a star (C. DM.—31° 10536), magnitude 9.5, having very nearly the position of the nebula N. G. C. 5253. The *Nova's* position differs from that of the nebula by only $1^s.4$ in Right Ascension and $18''$ in Declination, so that it was uncertain whether the C. DM. star referred to

the nebula, or to the *Nova.* In a small telescope with low power the appearance of the nebula is such that it might easily be mistaken for a star, 9.5 magnitude, though careful observation shows it to be hazy. This circumstance increases the uncertainty mentioned above.

On the nights of December 22, 1895 and January 2, 1896, Professor CAMPBELL measured the relative positions of the *Nova*, the nebula and three neighboring stars and compared the *Nova's* position with a Cordoba Zone star. In January and February I repeated these measurements. We obtained a close agreement of the nebula and C. DM. $-31°$ 10536, both in magnitude and position. This rendered it all but certain that the C. DM. star refers to the nebula.

At the time of making our measurements, we also estimated the brightness of the *Nova.* The relative positions of the *Nova*, the nebula and the stars used for comparison are shown in the accompanying diagram; the positions are as seen in an inverting



telescope. The diagram includes 24^s of Right Ascension and $4'$ of Declination, the center being at $\alpha = 13^h\ 32^m\ 48^s$, $\delta = -30°\ 59'$, referred to equinox of 1875.0. The star A is given in the *Cordoba Duchmusterung* as $9^m.7$. The others have been estimated as follows: B, 10^m; C, $10\frac{1}{2}^m$; D, $14\frac{3}{4}^m$; E, $15\frac{1}{2}^m$; and F, $16\frac{1}{4}^m$.

According to our estimates (see *Astronomical Journal*, No. 371), the *Nova* declined in brightness from 11.2 magnitude on December 22d, to 11.5 magnitude on February 19th.

I again looked up the *Nova* on June 11, 1896, and found that

it had decreased to 14.4 magnitude, and that it was surrounded by a faint, irregular nebula which seemed to extend continuously to the bright nebula, N. G. C. 5253.

On June 26th its brightness was estimated at 15¼, and on July 9th at nearly 16th magnitude. On the last date it was difficult to detect the star in the midst of the nebula surrounding it. On this date the nebula about the star was seen plainly to be continuous with the bright, adjacent nebula, N. G. C. 5253, of which it seems to be a part. When the star was brighter, the nebula about it was not seen; this was no doubt due to the overpowering light of the star, for as the star faded, the nebula became more and more conspicuous.

MOUNT HAMILTON, Cal., July 15, 1896.

LIST OF EARTHQUAKES IN CALIFORNIA FOR THE YEAR 1895.

COMPILED BY C. D. PERRINE.

The following list gives the dates and places of occurrence of earthquakes in California (including, also, a number outside of the State), compiled from observations at Mount Hamilton and reports received at the LICK Observatory, both by letter and newspaper. A number of disturbances have come under our notice which are not properly within our province, but which may possibly have escaped other compilers, and are, therefore, included.

This is a continuation of similar reports printed in these *Publications:* Vol. II, p. 74; Vol. III, p. 247; Vol. V, p. 127; Vol. VI, p. 41, and Vol. VII, p. 99. A more complete account will be published as a bulletin by the United States Geological Survey. The dates are civil dates. The times are Pacific standard (120th meridian).

Roman numerals enclosed in parentheses indicate the intensity on the ROSSI-FOREL scale. The reports of the Light-house Board, and of the Weather Bureau, should be consulted in this connection.

There are, as yet, but few stations on the Pacific Coast equipped with instruments for the observation of earthquakes.

February 11, 1892.

August 27, 1893.

August 22, 1894.

SUN SPOTS PHOTOGRAPHED AT LICK OBSERVATORY.

Members of the Society, therefore, can assist materially in making these reports more complete by sending to the LICK Observatory descriptions of shocks which come to their notice.

Several cases have been mentioned by the newspapers which, from their nature, seem doubtful. As we have not sufficient evidence to warrant their omission entirely, they are indicated by a question mark in parenthesis.

LIST OF EARTHQUAKE SHOCKS, 1895.

January 5—Mt. Hamilton, $3^h\ 4^m\ 57^s \pm$ A.M. One light shock. —A. L. C.

January 23—Ukiah, A.M. Heavy shock.

January 26—Helena (Mont.), 5 A.M.

February 25—Portland (Oregon), Tacoma (Wash.), 4:47 A.M. Reported by Mr. F. G. Plummer.

Edison, Sumner, Puyallup, and Steilacoom (Wash.).

March 1—At sea, off the Mendocino coast. Longitude, 125° 20′; latitude, 40°.

March 10—San Miguel Island (?).

March 12—Mt. Hamilton, $9^h\ 34^m\ 17^s$ P.M. (IV or V).

March 22—Steamboat Springs (Colo.), 1 P.M.

April 1—Eureka, 8:42 A.M.

April 6—San José, 6:45 A.M.

April 16—Port Townsend (Wash.).

April 17—Vacaville, 12:30 (P.M.?).

Virginia (Nev.), 6 P.M.

April 18—Island in eruption off the Mendocino coast (?).

April 19—Victoria (B. C.).

April 27—Colima (Mex.). Volcano in eruption.

May 1—Lakeport, 2:30 A.M.; Ukiah, 3 A.M.

May 21—Pinole, Contra Costa Co., 10:40 A.M. Explosion of nitro-glycerine works. Felt at Mt. Hamilton.

May 28 to 31—Peru and Chile. Several severe shocks and a tidal-wave.

June 11—Mount Baker (Wash.) in eruption (?).

June 15—Chimacum (Wash.), 8 P.M. It is reported that a large meteor fell, striking the earth with sufficient force to break crockery and glass in the neighborhood.

June 20—Mt. Hamilton, $9^h\ 43^m\ 26^s$ P.M.; Smith Creek.

June 23—Cocopah Mountains (Lower Calif.) in eruption (?).

June 24—Mt. Hamilton, $9^h\ 25^m\ 36^s$ P.M.—E. E. B.

$9^h\ 25^m\ 41^s$ P.M.—R. G. A.

July—Nanaimo (B. C.). A shock of earthquake was felt the week of July 9th.
July 26—Santa Barbara, 4:10 P.M.
August 4—Gilroy, 2 A.M.
August 15–17—Virginia (Nev.). Six shocks in two days.
October 7—Mills College, 7:17 P.M. Reported by Prof. Keep.
Albuquerque, Sabinal, Jorales (N. M.)
October 14—The tide-gauge of the U. S. Coast Survey at Sausalito shows evidences of a heavy storm or earthquake. The irregularities in the record began at 8:20 A.M. on October 14th, and lasted continuously for eighteen hours.
October 24—At sea, off the California coast. Latitude 43° 54′ north; longitude, 128° 32′ west.
October 31—Chicago (Ill.), $5^h\ 12^m\ 10^s$ A.M.—E. E. B.
November 7—Mt. Hamilton, $5^h\ 46^m\ 34^s$ A.M. Light shock.
$3^h\ 12^m\ 53^s$ P.M. (V).
San José, 3:14 P.M.; Santa Cruz, 3:15 P.M.
November 26—Mt. Hamilton, $1^h\ 56^m\ 35^s$ P.M. (II or III).
November—Kyuquot (B. C.) (Early in the month.)
December 8—Fairfield, Fullerton, Napa.
December 12—Ukiah, 12:40 (P.M.?).
December 23—Santa Barbara, 9:30 P.M.
December 28—Mt. Hamilton, $9^h\ 12^m\ 13^s$ A.M.

(TWENTY-THIRD) AWARD OF THE DONOHOE COMET-MEDAL.

The Comet-Medal of the Astronomical Society of the Pacific has been awarded to Dr. LEWIS SWIFT, Director of the LOWE Observatory, California, for his discovery of an unexpected comet on April 13, 1896.

The Committee on the Comet-Medal,

EDWARD S. HOLDEN,
W. W. CAMPBELL,
C. D. PERRINE.

June 13, 1896.

THE PHOTO-HELIOGRAPH.

INSIDE THE DARKROOM.

THE HELIOSTAT.

SOME RECENT SUN-SPOTS.*

By C. D. Perrine.

It has been thought that illustrations of a few of the more notable sun-spots of recent years might be of interest to the members of the Society. These illustrations are from negatives taken with the horizontal photoheliograph of the Lick Observatory. With one exception all of the groups shown have been enlarged 3¼-diameters; and none have been retouched. The three views of the instrument show it entire and in detail. These views were taken at the time of the transit of *Venus* in 1882 (for which the photoheliograph was mounted) and hence show the surroundings somewhat different from their appearance to-day. The instrument is essentially the same, however, the only important change being the substitution of a vertical exposing shutter for the horizontal one shown in the illustration.

A short description of the instrument may not be out of place here. As will be seen from the illustrations, the objective is fixed on a brick pier, and the photographic plate is placed on a similar pier, forty feet to the south, and inside of the dark room. A hood extends from the objective to the dark room, for the purpose of overcoming as far as possible atmospheric waves, and a blackened tube extends about half-way toward the objective to prevent direct light from entering the room. The rays from the Sun are reflected to the objective by a plane glass mirror which is mounted to the north, on the lower extremity of a polar axis. The frame containing the mirror is pivoted at right angles to the polar axis, thus permitting of its adjustment to the Sun's varying declination. The polar axis is moved by clock-work which keeps the Sun's image fixed in a horizontal direction. In this way is obviated the necessity of the usual equatorial mounting for following celestial objects. The exposure is given by a shutter falling vertically in front of and near the plate. This shutter has a horizontal slit whose width can be varied to give the required exposure. In summer the proper width is found to be about $\frac{1}{16}$ inch with a corresponding exposure of $0^s.002$, and in winter $\frac{1}{16}$ inch with an exposure of $0^s.004$.

Negatives made with the photoheliograph are well adapted

*The illustrations accompanying are from the *Photographic Times*.

for measurement to determine the positions of spots, but as the photographic plate remains fixed, the north pole of the Sun occupies different positions on the negative at different times of the day. In order to have a reliable reference line from which to measure, a plumb-line, with a very fine wire, is suspended in front of, and almost touching the sensitive plate, its image being impressed upon each plate. Then, by noting the time at which the photograph was taken, it becomes possible to locate the central meridian and the equator; all positions being referred to these two lines.

During the recent maximum there have been many interesting spots. A very notable group was the one of February, 1892, which is here reproduced without enlargement from the original negative by Professors SCHAEBERLE and CAMPBELL, the scale being about 191,000 miles to the inch. The large group of August, 1893, was hardly inferior in area and from its persistence was of unusual interest. It was a conspicuous object in July, again in its appearance the early part of August when it reached a maximum and still in September. It had dwindled to a small single spot the last of September, just before its disappearance. The view of this group on August 8th shows it at about its maximum. The view on August 31st shows the same group after the decline had set in, while September 27th is a view of it on its last apparition. The illustration of August 27, 1893, is of a single, nearly round spot just after its appearance on the eastern limb, and shows well the foreshortening due to its position. In August, 1894, a large, naked eye group was visible, and the illustration on August 22d shows it when near the western limb. The faculæ are very distinct. The changes in this group were unusually rapid and extended over large areas.

Among the many photographs secured are a number of spots of unusual interest, aside from size, but which require a more or less extended discussion to be of general interest.

MOUNT HAMILTON, Cal., July 16, 1896.

BROOKS' PERIODIC COMET, 1889 V = 1896 *c*.

By William J. Hussey.

The rediscovery of this interesting periodic comet, by M. Javelle at the Nice Observatory on the twentieth of June, renders this an appropriate time to pass in review its last appearance, and to give some account of the investigations which have been made relating to its past history.

The comet was first discovered on the sixth of July, 1889, by Mr. William R. Brooks, of Geneva, New York. It was described as a faint telescopic comet, somewhat elongated, having a stellar nucleus and a short, broad tail. At first it seemed of very little importance and for a time, partly owing to bad weather, it was very sadly neglected. The first elements of its orbit were computed by Dr. Chandler. From its direct motion and the smallness of the inclination of the plane of its orbit, he at once stated that it was almost certain to prove a comet of short period. Such is the case, its period being a little more than seven years.

Interest in the comet was awakened by Professor Barnard's discovery of August 1, 1889. While he was examining the region about the comet, he found two objects which proved to be companion comets. Each of these companions had a very small nucleus and a short, faint tail, "presenting a perfect miniature of the larger one, which was well developed, with a small nucleus, and a fan-shaped tail." These comets were called *B* and *C*, in the order of their distances from the principal comet, which was denoted by *A*. The comets *B* and *C* both preceded *A* in space, *B* at an angular distance of from 64″ to 74″, and *C* from 265″ to 357″, during the time they were under observation.

On the night of August 4th, he discovered two more very faint companions, denoted by *D* and *E*. *E* was not seen with certainty except on this occasion, and at no other time was *D* bright enough for measurement.

The observations of *B* cover twenty-three nights from its discovery to September 5th. It had then become very large and diffuse, and it was not seen after that date. The observations of *C* extend from its discovery to November 25th, after which time it was not seen. During the time it was visible, it varied considerably in appearance and brightness. In August

its brightness increased and it became more definite in form. About the middle of September it began to fade, at first gradually and then more rapidly. The companion *B* was seen at several other observatories, and *C* was observed at fifteen other places. *D* and *E* were seen only with the thirty-six-inch equatorial of the LICK Observatory.

The principal comet *A* remained visible long after its companions had disappeared. Professor BARNARD continued to observe it with the thirty-six-inch telescope until January 12, 1891, or 555 days after its discovery. No other comet has been observed through so long a period at one apparition.

This comet is chiefly interesting on account of its past history. This was first investigated by Dr. CHANDLER, after the comet had been under observation for only a few months, and while the elements of its orbit were still somewhat uncertain, and afterwards by Dr. POOR, whose later researches are based upon Dr. BAUSCHINGER'S excellent definitive elements.

Dr. CHANDLER pointed out that the comet's aphelion is near the orbit of *Jupiter*, and that its orbital velocity there is nearly the same as that of the planet. In consequence of this, when both happen to be in that region, they remain near each other for several months. This happened in 1886, when the comet approached nearer to *Jupiter* than the outer satellites, and it may be as near or nearer than the Fifth Satellite, and when for more than a hundred days its distance from the planet was less than a tenth of the distance of the Earth from the Sun. By this close approach to *Jupiter*, the comet experienced violent perturbations. Its orbit was completely changed. The line of apsides was reversed and turned through twenty degrees; the line of nodes was reversed and turned through nineteen degrees; the inclination was changed fourteen degrees. It now moves in a small ellipse with a period of a little more than seven years (7.07 years); it formerly moved in a much larger ellipse with a period very nearly four and a half times as long (31.38 years according to Dr. POOR). Its present aphelion has almost the same position as its former perihelion.

These changes are shown in Figure 1, by Dr. POOR. (Johns Hopkins University Circulars, May, 1894). The orbits of the Earth, *Jupiter* and *Saturn* are represented by circles and the present orbit of the comet by the small ellipse. The full-line portion of this ellipse indicates that part of the orbit described by the comet

while it was under observation from July 6, 1889, to January 12, 1891. The *exact* position of the orbit previous to the encounter with *Jupiter* in 1886 is unknown; the observations of the last apparition, extensive though they were, were not sufficient to settle this point definitively. The observations of the present

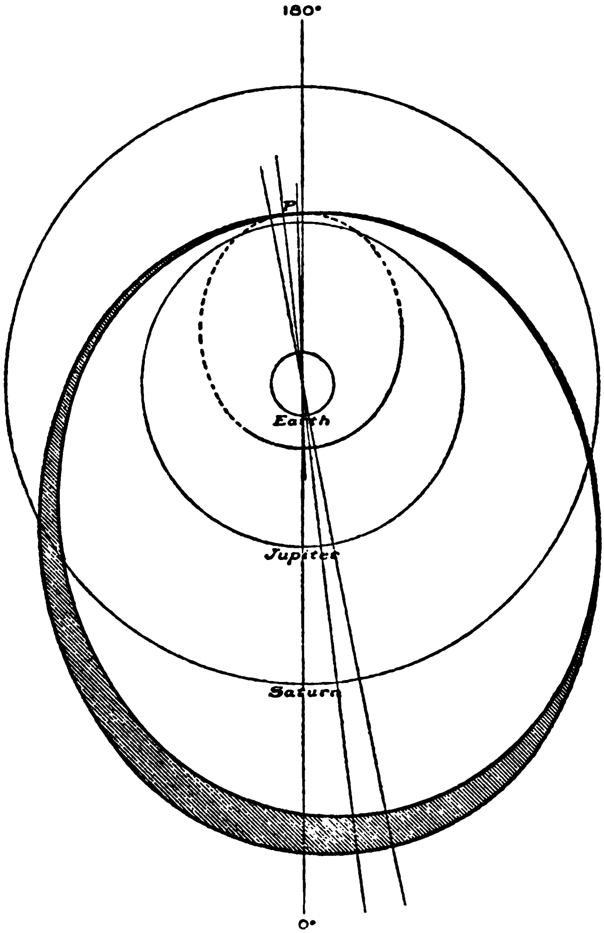


FIG. 1.

(1896) apparition will, it is expected, remove the slight indeterminateness that still exists. It is now known, however, that the former orbit of the comet lay somewhere within the shaded portion of the diagram, between the two large ellipses.

Some months before the comet reached perihelion in 1886, it came into the sphere of *Jupiter's* action, and for more than eight

months remained under its control. When it was near the planet, the Sun's disturbing action was small, and in consequence, the comet's motion for a time was very nearly the same as if it were moving under the influence of *Jupiter's* attraction alone. The orbit which it described about *Jupiter* was an hyperbola having an eccentricity only a little greater than unity. Had its velocity about *Jupiter* been somewhat less, its orbit about the planet would have been an ellipse, and it would then have become a comet-satellite. It happened, however, that its velocity was very little more than was necessary to carry it beyond the planet's predominating influence, and it thus narrowly escaped that fate.

To determine accurately the circumstances of the comet's motion when it was in the immediate neighborhood of *Jupiter* and its orbit previous to that time, requires a very accurate determination of its present orbit as a basis for the computation of the perturbations. Dr. BAUSCHINGER'S definitive elements, which were used by Dr. POOR in his later researches, are very near the truth, as is shown by the close agreement of the present position of the comet with that computed from these elements. For this reason we may accept Dr. POOR's mean results as substantially correct.

According to his researches the comet passed very close to the planet *Jupiter*, certainly within 158,000 miles of its centre or within 115,000 miles of its surface, and perhaps closer than the Fifth Satellite.

Figure 2 represents the passage of the comet through the planet's satellite system. The satellites all lie nearly in the same plane. Their orbits are represented by the circles I, II, III, IV, V. *Jupiter* is at the center. The comet's orbit was in a plane inclined nearly seventy degrees to that of the satellite system and intersecting it in the line of ☊☊′. The projection of the comet's path on the plane of the satellites' orbits is given, and the actual path being unknown, two curves (hyperbolas) are drawn, between which the true orbit is certainly known to lie. The most probable path of the comet is a curve about midway between the two. Concerning this figure, Dr. POOR says:

"A careful inspection of the figure will show that the comet rose up suddenly from below the satellites' orbits, then passed upwards, and almost directly over *Jupiter*, and then gradually descended, and finally passed below this orbital plane again. As the comet approached *Jupiter*, there could be no close approach

to any of the satellites, excepting at the point where it passed through the plane of their motion. But, on the other hand, as the comet receded from the planet, it hovered over the satellites, and close approaches might occur, provided that the satellites were in the proper places at the right time. A careful investigation of all possible positions of the comet, and of the satellites, showed that a collision was impossible; that the comet did not

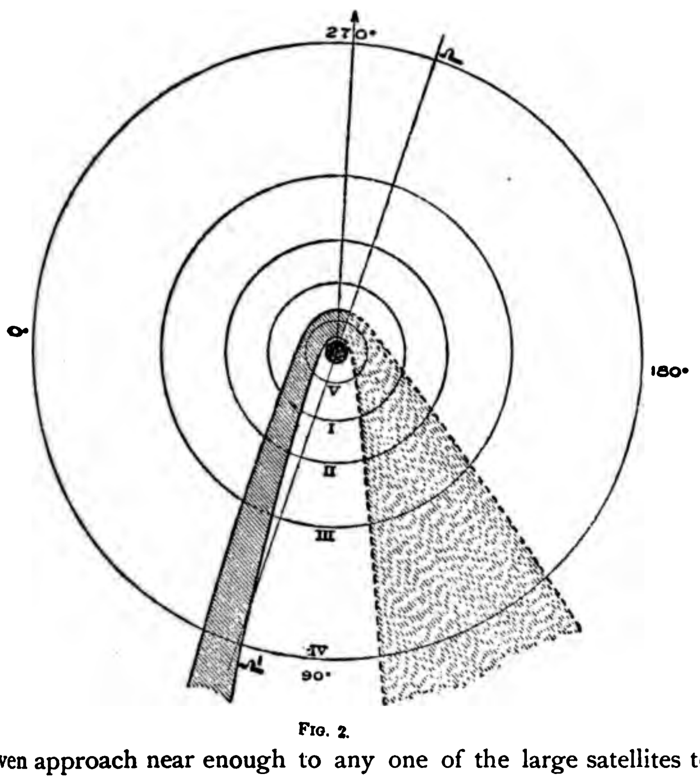


FIG. 2.

even approach near enough to any one of the large satellites to cause the slighest change in the relative motion of the nucleus about *Jupiter.*"

According to this result, the observed disruption of the comet could not have been produced by the action of the outer satellite, as seemed probable from the earlier investigation of Dr. CHANDLER. According to Dr. POOR'S work, the mean path of the comet intersected that of the Fifth Satellite, so that direct collision with it was possible. It is impossible to say that a collision did or did not take place, the uncertainties in the motions of the comet, and of the satellite, prevent a definite answer. The ob-

served disruption of the comet may have been caused by this satellite. It is more probable, however, that it was caused by the unequal attractions on the various parts of the comet, due to the great ellipticity of *Jupiter* itself. In this connection, it is of interest to quote the important proposition established by Dr. CHANDLER in his investigation of the orbit of the companion *C* with reference to the principal comet *A*, viz.: "That the force which led to the separation of the components *A* and *C*, whatever its nature, operated in the plane of the comet's orbit, and produced no change in that plane, or in the form of the conic section, but only in its size, and in the direction of its major axis."

Among the interesting questions raised by Dr. CHANDLER'S investigations is that which relates to the past history of this comet and the possibility of its identity with LEXELL'S comet of 1770.

This comet of 1770 was easily visible to the naked eye. It passed within half a million miles of the Earth. Its orbit when computed was found to be one having a period of about five and a half years. At first it seemed strange that a comet so bright should not have been seen before. But in 1767 it passed so close to *Jupiter* that its orbit was completely changed. Previous to that time it had been moving in a larger orbit with a perihelion distance so great (nearly the same as *Jupiter*), that it could not be seen from the Earth. In 1779 it approached very much closer to *Jupiter* than in 1767, and its orbit was again entirely changed, being again thrown into a larger ellipse with a greater perihelion distance. Since 1770 this comet has not been seen, and on this account it is commonly known as "The Lost Comet."

According to Dr. CHANDLER'S investigations it seemed for a time highly probable that the comet 1889 V was the fourth return of the celebrated LEXELL'S comet. Dr. POOR'S later work renders this quite doubtful. He says: "Between these two appulses, 1779 and 1886, there intervened a period of one hundred and seven years, which must be accurately accounted for in order to establish the identify of these two remarkable bodies. But assuming the substantial correctness of the present investigation, we cannot directly account for these necessary years. For the period of Comet V in 1884, or previous to its disturbance, has been shown to be 31.38 ± 1.50 years, which is not an aliquot part of 107. Hence, unless in the intervening years, the comet suffered other and marked disturbances in its orbit, the entire

question as to the identity between the two bodies falls at once. A further investigation shows us that such disturbances did take place, but leaves us utterly in the dark as to the resulting changes in the orbit. The uncertainty in the original observations become so magnified in this part of the comet's orbit, that we can no longer trace its path with absolute accuracy, we cannot say with certainty that the two comets are or are not identical. The probability seems to be that they are not one and the same body."

The observations of this year, 1896, will, it is expected, furnish the data by means of which it will be possible to remove the uncertainties that have existed concerning the present orbit of the comet. When this orbit is known with entire certainty, the circumstances of its passage through *Jupiter's* satellite system in 1886 and its history previous to that time, will become much more determinate.

The comet will not again approach close to *Jupiter* until 1922. It will then experience great perturbations and the elements of its orbit will be changed very considerably, but not at all to the extent they were in 1886.

MOUNT HAMILTON, Cal., July 22, 1896.

NOTICES FROM THE LICK OBSERVATORY.

PREPARED BY MEMBERS OF THE STAFF.

VARIABLE STARS.

The last number of the *Astronomical Journal* (No. 379) is devoted entirely to Dr. S. C. CHANDLER'S "Third Catalogue of Variable Stars." This catalogue is as complete as it can be made, containing the elements of all known variables carefully revised by means of all the published maxima and minima. The tables give the definitive notation for each star, its position for 1900, and for 1855, its annual variation, its degree of redness, its magnitudes at maximum and minimum, the interval in days and decimals of a day from minimum to the next succeeding maximum, the elements of maximum (including the epoch, the period, and any known irregularities in the light curve), and the basis of elements. The data in the column "Basis of Elements" have been arranged "in order to indicate, as well as can be done by so succinct a form of statement, the actual present condition of the observation of the various stars. This will enable observers to regulate their selection of the objects most needing observation." These columns also indicate that "very few stars within the reach of astronomers of the northern hemisphere have been seriously neglected."

Notes appended to the catalogue give the facts relating to the discovery of the variability of the several stars and other miscellaneous data of useful nature. Following these is a list of 130 suspected variables which require further observation before being admitted to the list of known variables. Attention is also called to Professor BAILEY'S discoveries of large numbers of variables in several star clusters; to missing *Durchmusterung* stars; and to suspected variables in the *Cordoba Durchmusterung*.

little, so long as no special pains are taken to eliminate the numerous systematic errors.

Let us suppose it is a question of determining the diameter of *Jupiter's* Satellite I, by micrometer measurements. The telescope forms an image of the satellite; but the image is *always too large*, owing to spherical aberration, chromatic aberration, diffraction, imperfect focusing, poor seeing. It is for the observer to measure the diameter of this image. But the image, already too large, is in effect still further enlarged by irradiation. The measures obtained refer not to the satellite, but to its enlarged image, and then include also the observer's personal error.

A few years ago an excellent observer made an excellent series of diameter measures of *Mars* for the purpose of determining the polar flattening. While the measures no doubt gave an excellent value of the polar flattening, the observer noticed that his measures of the diameter were 1½ seconds of arc larger than they should be according to the best determinations. A few years later he made another series of measures of the same planet, but using a larger telescope. His measures were about ⅘ second of arc greater than the generally accepted value. Scores of similar instances could be quoted showing that diameters are generally deduced too great.

A few observers have investigated their systematic errors, and have attempted in some cases to reduce their magnitude and in others to eliminate them entirely. In this connection M. BIGOURDAN'S measures of *Jupiter's* satellites are very important. He made three sets of observations:

1st. Before or during the setting of the Sun.

2d. Between sunset and dark.

3d. After dark, with field artificially illuminated.

His results for the four satellites, from long series of measures, are:

	I.	II.	III.	IV.
	$''$	$''$	$''$	$''$
Before sunset,	0.713	0.655	1.250	1.124
After sunset,	0.820	0.729	1.342	1.241
After dark,	0.893	0.851	1.551	1.356

The increase of the apparent diameter, as the darkness of the sky increased, is very evident. We need not look far for the reason. The satellites are bright. When they are observed on a bright-sky background, the effects of chromatic aberration, irradiation, etc., are largely reduced. His measures after dark are twenty-

five per cent. greater than those made on the bright sky; and although the night measures agree well with those obtained by other observers,* it seems to me that the daylight measures are much nearer the truth.

Daylight measures possess many of the advantages of heliometer or other double-image measures, and do not have their principal disadvantages. In the cases of *Venus* and *Mars*, and possibly some other of the nearer bodies, the great range in distance from the Earth enables us to eliminate the systematic errors very satisfactorily. For the more distant bodies the errors cannot thus be eliminated. In such cases—as well as in all cases—the observer is bound to reduce the magnitude of the systematic errors as far as possible. One of the most effective methods, in my judgment, is to make the observations when the Sun is above the horizon.

In 1894 I measured the diameter of *Mars*, (*a*) on the dark sky, (*b*) between daylight and sunrise, and (*c*) with the Sun well above the horizon. The advantages of the bright-sky background were very marked. Measures made with the utmost care at night, on the dark background, were systematically 0″.3 to 0″.7 greater than those made after sunrise. Measures made between dawn and sunrise progressively decreased as the sky brightened. From my discussion of a long series of observations made after sunrise, it appeared that their systematic error was 0″.05, whereas the systematic error of the night measures was about 0″.6.

W. W. CAMPBELL.

PROFESSOR KRUEGER.

CARL NICOLAUS ADALBERT KRUEGER, whose death was announced in a recent number of the *Astronomische Nachrichten*, was born at Marienburg, in Prussia, in 1832; was educated at Elbing and Wittenburg and at the University of Berlin. At the age of twenty-one, he was appointed assistant at the Bonn Ob-

* The principal values obtained by other observers are:

	I.	II.	III.	IV.
	″	″	″	″
W. STRUVE,	1.015	0.911	1.488	1.273
MÆDLER,	1.200	1.132	1.519	1.300
ENGLEMANN,	1.08	0.91	1.54	1.28
SECCHI,	0.985	1.054	1.609	1.496
HOUGH,	1.11	0.98	1.78	1.46
BURNHAM,	1.11	1.00	1.78	1.61
MICHELSON,	1.02	0.94	1.37	1.31
BARNARD,	1.048	0.874	1.521	1.430

servatory, under ARGELANDER. Here, with SCHÖNFELD as his colleague, his main work was the well-known *Durchmusterung*. In 1862 he was appointed director of the Observatory at Helsingfors, and professor in the University. Aside from his teaching, his principal care was the meridian observation of the zone $+ 55°$ to $+ 65°$, for the star catalogue of the *Astronomische Gesellschaft;* and when, in 1877, he was appointed director of the Observatory at Gotha, he continued and completed this work there, using the same instrument he had used at Helsingfors.

Besides his work on these two great catalogues, Professor KRUEGER found time for many important investigations of a less routine character. With the Bonn heliometer he made determinations of the parallaxes of *70 Ophiuchi*, *Lalande 2156*, and *O. Arg. 17415–6*, and a careful survey of the stars in the cluster *h Persei;* and, at Helsingfors, he published a research on the orbit of the minor planet, *Themis*, made with the purpose of determining the mass of *Jupiter*. Many other observations and mathematical investigations relating to the minor planets, the more interesting comets, and variable stars, were published during these years.

In 1880 Professor KRUEGER was chosen director of the Kiel Observatory, to fill the vacancy caused by the death of Dr. C. A. F. PETERS. Shortly afterward, he assumed, in addition, the editorial control of the *Astronomische Nachrichten*, which, from its hundredth volume (1880) has been published under the auspices of the *Astronomische Gesellschaft*. He was left free, however, in the editorial management of this celebrated journal, and its high character, in the past sixteen years, has been very largely due to him.

When the "Centralle Stelle für Astronomische Telegramme" was established, its administration was placed in the hands of Professor KRUEGER, who discharged its duties faithfully, and very successfully.

Before leaving Bonn, Professor KRUEGER married the daughter of ARGELANDER, and, following her mother's example, their daughter married an astronomer, Dr. KREUTZ, now at Kiel, and temporarily in charge of the *Astronomische Nachrichten*.

R. G. AITKEN.

Comet Notes.

Comet *IV* 1895 is still visible in the thirty-six inch telescope but is not brighter than a 16th magnitude star. According to theory, it should be between 11th and 12th magnitude.

Comet *a* 1896 has been lost to view for about two months its apparent motion having carried it into the Sun's rays.

C. D. Perrine.

Comet *c* 1896, Swift. In the latter part of May, and in June the brightness of this comet decreased very rapidly; in fact, out of all proportion to the law of the inverse squares of its distances from the Earth and from the Sun. This was probably due to its want of any visible nucleus, and to its diffuseness. It remained of large apparent size as long as it was visible.

W. J. Hussey.

The Yerkes Observatory.

No. 43 of these *Publications* contains a short account of the Yerkes Observatory, of the University of Chicago, by the Director, Professor George E. Hale. He has recently contributed an article on the same subject to the *Astronomische Nachrichten* (No. 3356) from which it appears that a twenty-four inch reflector of eight feet focal length will occupy one of the smaller domes instead of the sixteen-inch refractor at first proposed.

This article also states that the publications of the Observatory will include *Bulletins*, containing announcements of results, brief descriptions of new buildings and instruments, and notes; *Contributions*, consisting of papers contributed to scientific journals; *Annals*, containing detailed accounts of special researches; the *Astrophysical Journal* (now in its fourth volume); and *Terrestrial Magnetism* (now in its first volume).

The staff of the observatory is as follows: George E. Hale, Director and Astrophysicist; S. W. Burnham, Astronomer; E. E. Barnard, Astronomer; F. L. O. Wadsworth, Astrophysicist; L. A. Bauer, Geophysicist; Ferdinand Ellerman, Assistant; G. Willis Ritchey, Optician; Edmund Kandler, Mechanician; William Gaertner, Mechanician.

Messrs. T. J. J. See and Kurt Laves will give graduate and undergraduate instruction in theorectical and practical astronomy.

at the University in Chicago, and superintend the work of the Students' Observatory on the University campus. A library and a museum are being established at the Observatory, for which contributions are requested.

The Observatory is to be dedicated on the 15th of October.

R. G. AITKEN.

MERIDIAN-CIRCLE FOR SALE.

The meridian-circle of the Georgetown College Observatory has been replaced by a photographic transit instrument, and is to be disposed of for want of room.

The instrument has two large circles of forty-five inches in diameter, one for clamping, the other with a fine graduation on silver, reading to five minutes of arc; and an object-glass of four inches aperture. There are eight microscopes, four on each pier, reading directly single seconds of arc; a micrometer with four eye-pieces, one for collimating over mercury; and a striding-level. The instrument was made by TROUGHTON & SIMMS, and cost originally $2200. A few years ago it was put in good working order by FAUTH & Co. A full description of it will be found in the first publication of the observatory, 1852, p. 193 ss. The observing and reversing-chairs will be given with the instrument.

Apply to the Director of Georgetown College Observatory, Washington, D. C.

EIGHT-INCH CLARK EQUATORIAL FOR SALE.

The Napa College proposes to sell its eight-inch equatorial. The object-glass was made by ALVAN CLARK & SONS, and the mounting by FAUTH & Co., at a cost of $2300. Intending purchasers should address Hon. S. E. HOLDEN, Napa. E. S. H.

MIRA CETI.

[Extract from a private letter from W. STEADMAN ALDIS].

"I was much interested in the observations of *Mira Ceti* in the last number of the A. S. P. *Publications* [No. 48]. I had never watched it myself until last December. I could first glimpse it with the naked eye about December 15th, six days after the maximum as given in *The Observatory*. * * * Owing to moonlight, and bad weather, I could not catch it again until December 29th, when it was quite plain to the naked eye, and

grew steadily brighter for some days. On January 6th and 7th I noted it as distinctly brighter than δ *Ceti*. Bad weather came on, and I did not see it again till January 20th and 21st, when it seemed to me somewhat brighter than on the 7th. On February 12th I noted it, nearly as bright as γ, distinctly inferior to α *Ceti*.

"February 16th, *Mira* still as bright as γ.

"February 21st, *Mira* less bright than γ.

"Bad weather and the low altitude of *Mira* later on prevented any more observations; but there could be no doubt that the maximum was much later than the time given in the almanacs."

Views of Mountain Observatories.

The Smithsonian Institution is now printing in its *Miscellaneous Collections* a memoir on "Mountain Observatories in America and Europe," by Dr. Edward S. Holden. The illustrations to this volume are printed in the present number of the *Publications*. The titles of the cuts are a sufficient explanation. A number of the cuts have previously been printed by the A. S. P.; but most of them are new to our members. It may be convenient and interesting to collect all of them in one place.

The Committee on Publication.

A Meteor in Mexico (July 22, 1896.)

City of Mexico, July 23.—A remarkable phenomenon occurred yesterday at the mine of Santos Reyes, in the State of Chihuahua. At 3 o'clock a tremendous explosion was heard, and an enormous mass of burning matter was seen to fall from the heavens, striking the side of a mountain and bringing with it in its course entire cliffs. It finally plunged 700 feet into the ground, making a hole from which boiling water still issues. A heavy rain occurred immediately after the descent of the meteor. The meteor destroyed the house of a miner, killing his two children.

Bright Meteor, July 31, 1896.

At $10^h\ 33^m\ 26^s$, P. S. T., just as the Moon was rising, the sky was illumined by a flash, and upon looking up a train about five degrees long was seen to extend from the direction of *Arcturus*, the center of the train being about R. A. $13^h\ 40^m$, Decl. $+20°$.

My attention was attracted entirely by the illumination of the sky, which was fully as brilliant as from a flash of lightning. The train remained visible for three or four seconds only.

C. D. P.

Sixteen-Inch Clark Refractor for Sale.

The sixteen-inch Clark refractor, shown in the cut facing page 186 of Volume VIII of these *Publications*, with its apparatus, is for sale at a considerable reduction from its first cost. For particulars apply to Dr. Lewis Swift, Echo Mountain, California, U. S. A.

E. S. H.

Heights of Mountain-Observatories.

It may be a convenience to have the following small table of the heights of the principal mountain-observatories and stations of the world.

E. S. H.

Abastouman,	4600	Mt. Pilatus,	6785
Alto de los Huesos,	13300	Mt. Washington,	6279
Arequipa,	8060	Mt. Whitney—Summit,	14900
Ben-Nevis,	4368	Mountain Camp,	12000
Chachani—Summit,	20000	Lone Pine,	3700
Station,	16650	Mt. Wilson,	6000
Colorado Springs,	6035	Mürren (Railway),	5350
Cuzco,	11000	Nice, Mont-Gros,	1100
Denver (Chamberlin Observatory)	5400	Petropolis (Brazil),	3500
Echo Mountain,	3500	Pic-du-Midi,	9439
El Misti—Summit,	19200	Pike's Peak,	14134
Station	15600	Popocatapetl,	18000
Etna,	9652	Puno,	12608
Flagstaff,	7300	Puy-de-Dome,	4593
Jungfrau,	15700	Quito,	9543
Kodiakanal,	7700	Riffel (Zermatt),	8000
La Joya,	4150	Rigi,	5873
La Paz,	12050	St. Bernard,	8130
Lick Observatory,	4209	Santa Ana,	3000
Misti—Summit,	19200	Säntis,	8200
Station,	15600	Seven Lakes (Colorado),	10964
Mollendo,	100	Sherman,	8335
Mont-Blanc—M. Janssen's Observatory,		Sonnblick,	9843
Summit,	15780	Tacubaya,	7500
M. Vallot's Observatory,	14321	Teneriffe—Summit,	12198
Chamounix,	3396	Alta Vista,	10702
Mont-Gros (Nice),	1100	Guajara,	8903
Mont-Meige,	13000	Vinocaya,	14360
Mont Mounier,	8993	Wendelstein,	6027
Mt. Hamilton,	4209		

Gifts to the Lick Observatory.

Miss Caroline W. Bruce, of New York City, has given the Observatory a sum of money to procure a large comet-

seeker, and to provide photometers for visual use with the thirty-six-inch equatorial.

Mr. WALTER W. LAW, of Scarboro'-on-Hudson, has likewise made a liberal gift towards providing for the publication of the Observatory Atlas of the Moon mentioned in these *Publications*, Volume VIII, page 187. The grateful thanks of the Observatory are offered to these friends, who have made it possible to undertake new work. EDWARD S. HOLDEN.

A BRILLIANT METEOR (JULY 29, 1896).

[Extract from a letter of Mr. F. H. SEARES, Berkeley.]

"The meteor made its appearance at $10^h\ 17^m$, P. S. T., at a point about 10° northwest of *Vega*, passed downward directly over the star *Mizar*, and, exploding, disappeared about 15° above the horizon. In brilliancy and appearance it was not unlike an ordinary arc lamp seen from a distance of one mile. The trail disappeared almost immediately."

HONORARY DEGREE CONFERRED UPON PROFESSOR HOLDEN.

The University of the Pacific, on its last Commencement Day, conferred the honorary degree of Doctor of Science upon the Director of the LICK Observatory.

CENTENARY OF THE BIRTH OF JAMES LICK.

Mr. LICK was born in Fredericksburg, Pennsylvania, August 25, 1796. He died in San Francisco, October 1, 1876. The centenary of his birth will be kept as a holiday at the LICK Observatory, and an account of the work at the Observatory which he founded will be printed in the California newspapers.

EDWARD S. HOLDEN.

TOTAL SOLAR ECLIPSE OF AUGUST, 1896, IN JAPAN.

A cable-telegram from Professor SCHAEBERLE, in charge of the LICK Observatory Eclipse Expedition recites that the sky was wholly cloudy at his station. E. S. H.

August 11, 1896.

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OFFICERS OF THE MEXICAN SECTION.

Executive Committee—Messrs. Camilo Gonzalez, Francisco Rodriguez Rey.

NOTICE.

The attention of new members is called to Article VIII of the By-Laws, which provides that the annual subscription, paid on election, covers the *calendar* year only. Subsequent annual payments are due on January 1st of each succeeding calendar year. This rule is necessary in order to make our book-keeping as simple as possible. Dues sent by mail should be directed to Astronomical Society of the Pacific, 819 Market Street, San Francisco.

It is intended that each member of the Society shall receive a copy of each one of the *Publications* for the year in which he was elected to membership and for all subsequent years. If there have been (unfortunately) any omissions in this matter, it is requested that the Secretaries be at once notified, in order that the missing numbers may be supplied. Members are requested to preserve the copies of the *Publications* of the Society as sent to them. Once each year a title-page and contents of the preceding numbers will also be sent to the members, who can then bind the numbers together into a volume. Complete volumes for past years will also be supplied, to members only, so far as the stock in hand is sufficient, on the payment of two dollars to either of the Secretaries. Any non-resident member within the United States can obtain books from the Society's library by sending his library card with ten cents in stamps to the Secretary A. S. P., 819 Market Street, San Francisco, who will return the book and the card.

The Committee on Publication desires to say that the order in which papers are printed in the *Publications* is decided simply by convenience. In a general way, those papers are printed first which are earliest accepted for publication. It is not possible to send proof sheets of papers to be printed to authors whose residence is not within the United States. The responsibility for the views expressed in the papers printed rests with the writers, and is not assumed by the Society itself.

The titles of papers for reading should be communicated to either of the Secretaries as early as possible, as well as any changes in addresses. The Secretary in San Francisco will send to any member of the Society suitable stationery, stamped with the seal of the Society, at cost price, as follows: a block of letter paper, 40 cents; of note paper, 25 cents; a package of envelopes, 25 cents. These prices include postage, and should be remitted by money-order or in U. S. postage stamps. The sendings are at the risk of the member.

Those members who propose to attend the meetings at Mount Hamilton during the summer should communicate with "The Secretary Astronomical Society of the Pacific" at the rooms of the Society, 819 Market Street, San Francisco, in order that arrangements may be made for transportation, lodging, etc.

PUBLICATIONS ISSUED BI-MONTHLY.

(February, April, June, August, October, December.)

FIGURE 1:—THE ASTRONOMICAL OBSERVATORY ON THE SUMMIT OF ETNA, (9,652 feet).

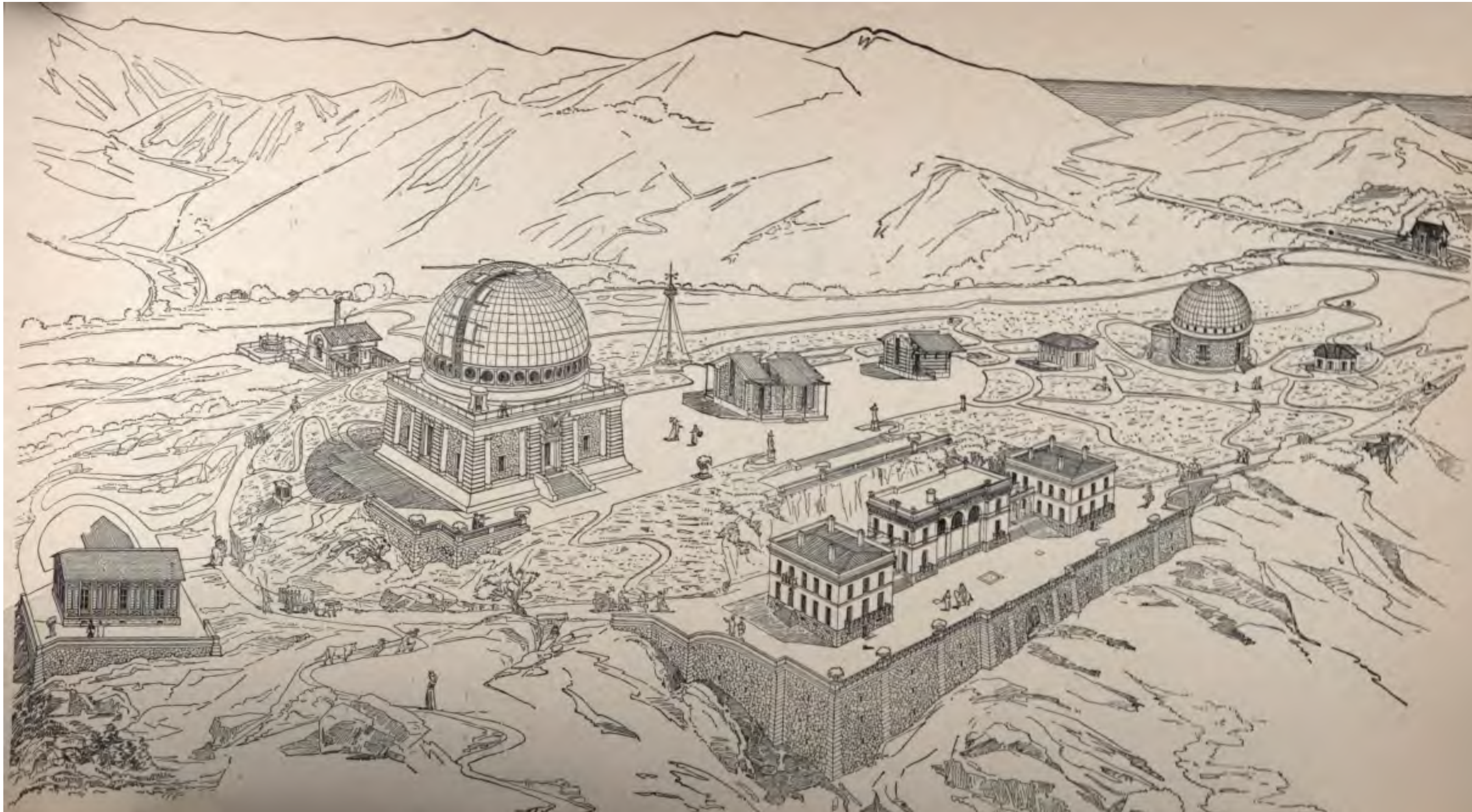


FIGURE 2.—THE ASTRONOMICAL OBSERVATORY OF NICE. (1,100 feet).

FIGURE 5:—ON THE WAY TO THE MONT-BLANC OBSERVATORY—(The Refuge at Grands Mulets).

FIGURE 6:—VIEW OF MONT-BLANC, TAKEN FROM THE *BRÉVENT*.

FIGURE 7:—ON THE WAY TO THE MONT-BLANC OBSERVATORY—(Passage of a Crevasse).

FIGURE 8:—M. JANSSEN'S OBSERVATORY AT THE SUMMIT OF MONT-BLANC, (15, 780 feet)

FIGURE 9:—THE METEOROLOGICAL STATION ON THE SÄNTIS (8,200 feet).

FIGURE 11:—PANORAMA OF THE JUNGFRAU RANGE (Eiger, Mönch, Jungfrau).

FIGURE 12:—MT. CHACHANI, FROM THE AREQUIPA OBSERVATORY.

FIGURE 13:—EL MISTI, FROM THE AREQUIPA OBSERVATORY.

FIGURE 14:—ILLAMPU (the Highest of the Andes) AND THE SORATA RANGE, SEEN OVER LAKE TITICACA.

FIGURE 15:—CHIMBORAZO, (20,545 feet).

FIGURE 16:—CHIMBORAZO FROM A POINT 17,450 FEET ABOVE SEA.

FIGURE 17.—DISTANT VIEW OF PIKE'S PEAK, (14,134 feet).

FIGURE 18:—MT. WHITNEY (14,900 feet), FROM THE WEST.

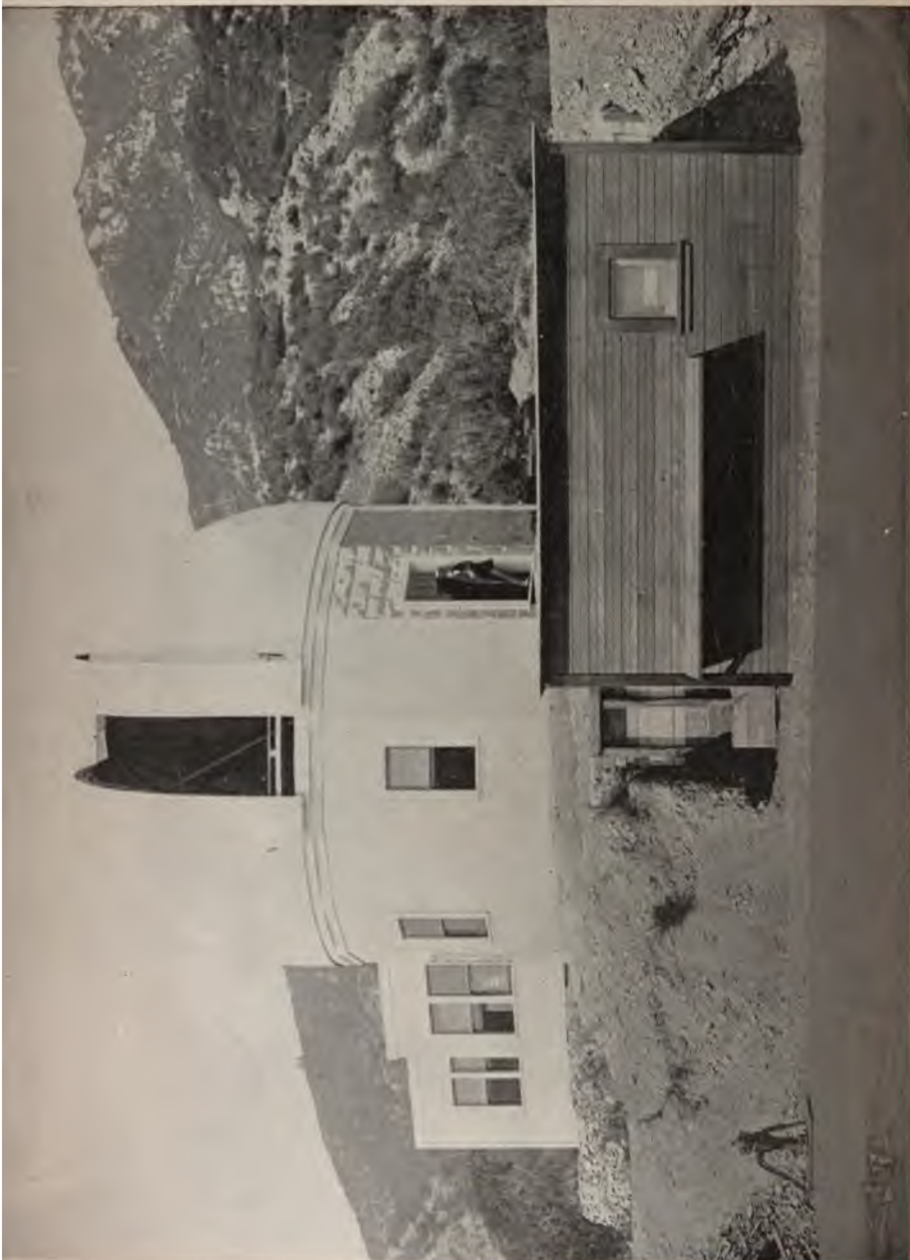
FIGURE 19:—MOUNTAIN CAMP, MT. WHITNEY CALIFORNIA,
(12,000 feet).

FIGURE 20:—VIEW OF THE RAILWAY TO THE SUMMIT OF PIKE'S PEAK.

FIGURE 21:—VIEW OF THE RAILWAY TO THE SUMMIT OF PIKE'S PEAK.

FIGURE 22:—VIEW OF THE RAILWAY TO THE SUMMIT OF PIKE'S PEAK.

FIGURE 23:—VIEW OF THE RAILWAY TO THE SUMMIT OF PIKE'S PEAK.



PUBLICATIONS

OF THE

Astronomical Society of the Pacific.

VOL. VIII. SAN FRANCISCO, CALIFORNIA, OCTOBER 1, 1896. No. 52.

PLANETARY PHENOMENA FOR NOVEMBER AND DECEMBER, 1896.

BY PROFESSOR MALCOLM MCNEILL.

NOVEMBER, 1896.

Mercury is a morning star at the beginning of the month, having passed greatest western elongation on October 24th. For the first week of November it rises an hour or more before sunrise, and there is a fair chance for visibility under favorable atmospheric conditions. After that it rapidly approaches the Sun and comes to superior conjunction on the afternoon of November 28th.

Venus is evening star, and throughout the month sets from an hour and a half to two hours and a half after sunset. It is moving very rapidly eastward among the stars, forty degrees during the month, from a position near the red star *Antares* in *Scorpio*, through that constellation and *Sagittarius*, nearly to the west boundary of *Capricornus*.

Mars is coming near to opposition and is quite a conspicuous object in the sky. By the end of the month it rises very soon after sunset. It is on the borders of the constellations *Taurus* and *Gemini*, and after November 1st it retrogrades, moving westward about nine degrees during the month. During the month its distance from us in millions of miles lessens from sixty-one to about fifty-two.

Jupiter is in better position for observation, rising before midnight at the end of the month. During the month it moves about three degrees eastward and southward in the constellation

Leo, and at the beginning of the month it is about eight degrees from the first magnitude star *Regulus*. It is in quadrature with the Sun on November 30th.

Saturn is too near the Sun for observation during the month. It passes conjunction and changes from an evening to a morning star on the morning of November 13th. By the end of the month it rises more than an hour before the Sun, but its dull color and lack of brightness will make it a hard object to see without the telescope.

Uranus is near *Saturn* and passes conjunction with the Sun only three days later, on November 16th. So it is also in bad position for naked eye visibility.

Neptune is in the constellation *Taurus*, a few degrees to the west of *Mars*.

DECEMBER.

The Earth is in perihelion at about 4 A.M., December 31st, P. S. T.

Mercury is an evening star and towards the end of the month is nearly out to greatest eastern elongation. For the last ten days of the month it remains above the horizon about an hour after sunset, and it may be seen if the sky is clear.

Venus is also an evening star, and is getting well out toward greatest elongation. By the end of the month it sets nearly three hours and one-half after sunset. It moves eastward and northward during the month nearly forty degrees, from the eastern part of *Sagittarius* through *Capricornus*.

Mars is in the best position for observation since October, 1894. It comes to opposition with the Sun on December 10th, 9 P.M., P. S. T., and is above the horizon practically throughout the whole night. It moves westward about eleven degrees during the month in the eastern part of the constellation *Taurus*, and at the end of the month is not far from the first magnitude red star *Aldebaran*. On the night of December 18th it passes about one degree south of the Moon. At opposition its distance from us in millions of miles is about fifty-two and one-half. The nearest approach to the Earth occurs about a week earlier, and the planet is then about half a million miles nearer to us. The planet passed its perihelion in June, six months before coming to opposition, and its distance at opposition is therefore much greater than it was during the last two oppositions which

occurred much nearer the times of perihelion passage. In October, 1894, the least distance was 40,000,000 miles, and in August, 1892, it was only 35,000,000. The great northern declination of *Mars* makes the present opposition not a bad one for observations in the Northern Hemisphere, since the meridian altitude of the planet is seventeen degrees greater than it was at the opposition of 1894, and forty-nine degrees greater than at the opposition of 1892; the great increase in altitude almost, if not quite, counterbalances the loss of light from increased distance.

By the end of the month *Jupiter* rises at about half-past nine. It is in the constellation *Leo*, and moves about one degree eastward before December 25th. It then turns and begins to move westward.

Saturn is a morning star, and by the end of the month rises more than three hours before the Sun. It moves about three degrees eastward in the constellation *Libra*. The rings are slightly wider open than they were before conjunction.

Uranus is very near *Saturn* and is also moving eastward. The two planets are in conjunction on the morning of December 28th, when *Uranus* is not quite two degrees south of *Saturn*.

Neptune is near *Mars*, and is in conjunction with it early in the month. It is in opposition with the Sun on the morning of December 10th.

Explanation of the Tables.

The phases of the Moon are given in Pacific Standard time. In the tables for Sun and planets, the second and third columns give the Right Ascension and Declination for Greenwich noon. The fifth column gives the local mean time for transit over the Greenwich meridian. To find the local mean time of transit for any other meridian, the time given in the table must be corrected by adding or subtracting the change per day, multiplied by the fraction whose numerator is the longitude from Greenwich in hours, and whose denominator is 24. This correction is seldom much more than 1^m. To find the standard time for the phenomenon, correct the local mean time by *adding* the difference between standard and local time if the place is west of the standard meridian, and *subtracting* if east. The same rules apply to the fourth and sixth columns, which give the local mean times of rising and setting for the meridian of Greenwich. They are roughly computed for Lat. 40°, with the noon Declination and

time of meridian transit, and are intended as only a rough guide. They may be in error by a minute or two for the given latitude, and for latitudes differing much from 40° they may be several minutes out.

Phases of the Moon, P. S. T.

		H. M.
New Moon,	Nov. 4,	11 27 P. M.
First Quarter,	Nov. 11,	9 41 P. M.
Full Moon,	Nov. 20,	2 25 A. M.
Last Quarter,	Nov. 27,	6 44 P. M.

The Sun.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Nov. 1.	14 29	— 14 42	6 35 A.M.	11 44 A.M.	4 53 P.M.
11.	15 9	— 17 39	6 45	11 44	4 43
21.	15 50	— 20 6	6 57	11 46	4 35
Dec. 1.	16 33	— 21 57	7 8	11 49	4 30

Mercury.

Nov. 1.	13 31	— 7 21	5 11 A.M.	10 46 A.M.	4 21 P.M.
11.	14 30	— 13 36	5 52	11 6	4 20
21.	15 33	— 19 9	6 36	11 29	4 22
Dec. 1.	16 39	— 23 11	7 19	11 55	4 31

Venus.

Nov. 1.	16 31	— 22 57	9 9 A.M.	1 46 P.M.	6 23 P.M.
11.	17 24	— 24 40	9 31	2 0	6 29
21.	18 18	— 25 11	9 47	2 14	6 41
Dec. 1.	19 12	— 24 27	9 58	2 28	6 58

Mars.

Nov. 1.	5 57	+ 24 13	7 45 P.M.	3 14 A.M.	10 43 A.M.
11.	5 55	+ 24 41	7 1	2 32	10 3
21.	5 46	+ 25 9	6 11	1 44	9 17
Dec. 1.	5 31	+ 25 31	5 15	12 50	8 25

Jupiter.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Nov. 1.	10 32	+ 10 10	1 18 A.M.	7 48 A.M.	2 22 P.M.
11.	10 37	+ 9 42	12 41	7 14	1 47
21.	10 42	+ 9 19	12 7	6 39	1 11
Dec. 1.	10 45	+ 9 1	11 32 P.M.	6 3	12 34

Saturn.

Nov. 1.	15 14	− 15 55	7 24 A.M.	12 28 P.M.	5 32 P.M.
11.	15 18	− 16 14	6 51	11 54 A.M.	4 57
21.	15 23	− 16 32	6 17	11 19	4 21
Dec. 1.	15 28	− 16 50	5 44	10 45	3 46

Uranus.

Nov. 1.	15 26	− 18 31	7 46 A.M.	12 41 P.M.	5 36 P.M.
11.	15 29	− 18 40	7 10	12 4	4 58
21.	15 31	− 18 49	6 33	11 27 A.M.	4 21
Dec. 1.	15 34	− 18 58	5 57	10 50	3 43

Neptune.

Nov. 1.	5 16	+ 21 38	7 16 P.M.	2 33 A.M.	9 50 A.M.
11.	5 15	+ 21 37	6 36	1 53	9 10
21.	5 14	+ 21 36	5 55	1 12	8 29
Dec. 1.	5 14	+ 21 34	5 15	12 32	7 49

Eclipses of *Jupiter's* Satellites, P. S. T.

(Off left-hand limb, as seen in an inverting telescope.)

		H. M.			H. M.
III, R,	Nov. 3.	1 41 P. M.	III, D,	Nov. 18.	3 36 A. M.
II, D,	6.	12 23 A. M.	III, R,	18.	7 7 A. M.
I, D,	6.	5 38 A. M.	II, D,	20.	5 34 A. M.
I, D,	8.	12 7 A. M.	I, D,	22.	3 53 A. M.
III, D,	10.	11 38 P. M.	I, D,	23.	10 21 P. M.
III, R,	11.	3 9 A. M.	I, D,	29.	5 46 A. M.
II, D,	13.	4 59 A. M.	II, D,	30.	9 29 P. M.
I, D,	15.	2 0 A. M.	I, D,	31.	12 14 A. M.

Phases of the Moon, P. S. T.

		H. M.
New Moon,	Dec. 4,	9 51 A. M.
First Quarter,	Dec. 11,	4 29 P. M.
Full Moon,	Dec. 19,	8 5 P. M.
Last Quarter,	Dec. 27,	4 9 A. M.

The Sun.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Dec. 1.	16 33	−21 57	7 8 A.M.	11 49 A.M.	4 30 P.M.
11.	17 17	−23 5	7 17	11 54	4 31
21.	18 1	−23 27	7 24	11 59	4 34
31.	18 45	−23 3	7 27	12 4 P.M.	4 41

Mercury.

Dec. 1.	16 39	−23 11	7 19 A.M.	11 55 A.M.	4 31 P.M.
11.	17 47	−25 17	7 57	12 24 P.M.	4 51
21.	18 57	−25 2	8 27	12 55	5 23
31.	20 2	−22 17	8 41	1 21	6 1

Venus.

Dec. 1.	19 12	−24 27	9 58 A.M.	2 28 P.M.	6 58 P.M.
11.	20 4	−22 32	10 2	2 41	7 20
21.	20 54	−19 34	10 1	2 52	7 43
31.	21 41	−15 45	9 55	3 0	8 5

Mars.

Dec. 1.	5 31	+25 31	5 15 P.M.	12 50 A.M.	8 25 A.M.
11.	5 14	+25 40	4 12	11 48 P.M.	7 24
21.	4 58	+25 35	3 18	10 53	6 28
31.	4 46	+25 24	2 28	10 2	5 36

Jupiter.

Dec. 1.	10 45	+ 9 1	11 32 P.M.	6 3 A.M.	12 34 P.M.
11.	10 47	+ 8 50	10 56	5 26	11 56 A.M.
21.	10 49	+ 8 46	10 17	4 47	11 17
31.	10 48	+ 8 50	9 38	4 8	10 38

Saturn.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Dec. 1.	15 28	−16 50	5 44 A.M.	10 45 A.M.	3 46 P.M.
11.	15 33	−17 6	5 10	10 10	3 10
21.	15 37	−17 21	4 35	9 35	2 35
31.	15 41	−17 34	4 1	9 0	1 59

Uranus.

Dec. 1.	15 34	−18 58	5 57 A.M.	10 50 A.M.	3 43 P.M.
11.	15 36	−19 7	5 21	10 14	3 7
21.	15 39	−19 14	4 45	9 37	2 29
31.	15 41	−19 22	4 8	8 59	1 50

Neptune.

1896.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Dec. 1.	5 14	+21 34	5 15 P.M.	12 32 A.M.	7 49 A.M.
11.	5 12	+21 33	4 30	11 47 P.M.	7 4
21.	5 11	+21 32	3 49	11 6	6 23
31.	5 10	+21 30	3 9	10 26	5 43

Eclipses of *Jupiter's* Satellites, P. S. T.

(Off left-hand limb, as seen in an inverting telescope.)

			H. M.				H. M.
IV, D,	Dec.	4.	12 12 A. M.	IV, D,	Dec.	20.	6 10 P. M.
IV, R,		4.	4 49 A. M.	IV, R,		20.	10 45 P. M.
II, D,		8.	12 5 A. M.	III, D,		23.	11 23 P. M.
I, D,		8.	2 7 A. M.	I, D,		24.	12 21 A. M.
I, D,		9.	8 35 P. M.	III, R,		24.	2 52 A. M.
II, D,		15.	2 41 A. M.	II, D,		25.	6 34 P. M.
I, D,		15.	4 0 A. M.	I, D,		31.	2 14 A. M.
III, D,		16.	7 25 P. M.	III, D,		31.	3 21 A. M.
III, R,		16.	10 55 P. M.	III, R,		31.	6 50 A. M.

OBSERVATIONS WITH A FOUR-INCH TELESCOPE OF THE RECENT MAXIMA OF THE VARIABLE STARS R AND S *SCORPII.*

BY MISS ROSE O'HALLORAN.

1896. May 5th. R *Scorpii* is discernible as a yellow star of about tenth magnitude.

May 31st. It has been observed on several occasions since May 5th, but no increase of brightness was detected at any time. S *Scorpii* is not visible.

June 2d. This is the date of the predicted maximum of R, but there is little increase in the last month. S is just discernible.

June 5th. S is nearly as bright as R.

June 6th. They are of equal brightness.

June 8th. R compared with an adjacent star seems to have declined slightly.

June 9th. S seems the brighter of the two now. This is the date of its predicted maximum.

June 11th. R has declined further.

June 15th. R is scarcely visible.

June 18th. R is invisible in the moonlight. S has not decreased.

June 19th. S is still visible.

June 20th. It is faintly visible in the moonlight.

June 28th. After several nights of clouds and moonlight S is seen to have lost little if any of its faint lustre. R is invisible.

July 1st. S is not noticeably changed.

July 2d. It is still visible.

July 9th. It is barely discernible through clouds.

July 10th. It has decreased in light.

July 11th and 12th. It was barely discernible, and when looked for after a few cloudy nights it had sunk to invisibility. Its period is given as 176 days, and that of R, about 223 days. They are alike in tint and their visible range of variation was about from tenth to eleventh magnitude.

SAN FRANCISCO, August, 1896.

LUNAR ECLIPSE, AUGUST 22, 1896.

By Allen H. Babcock.

A heavy fog which rolled in over San Francisco and Oakland early in the evening, prevented any chance of observing the eclipse at either place. As a last resort it was decided to climb Chaparral Hill (1920 feet high), directly in the rear of the University of California, Berkeley, in the hope of getting above the fog. The result was all that could be desired, except that during the first contact with the shadow and for some few minutes after, light fleecy clouds made the Moon's image a little hazy. The first contact was observed with a pair of marine glasses of fairly high power and good definition. Mr. B. H. Pendleton counted time, and the shadow was first seen at $9^h\ 24^m$ P. S. T., nearly thirty seconds before predicted time. (See also Mr. Perrine's time of first contact with shadow). At first the shadow showed simply as a darkening of the surface, no definite color being apparent, but as the eclipse progressed, the upper part of the shadow, that part toward the illuminated region of the Moon's surface, assumed a decided greenish tinge, while below, toward the center of the shadow, it was a bright copper color, shading off darker toward the south edge of the Moon. At $11^h\ 30^m$ the greenish band was about one-third the total diameter of the eclipsed segment, and ran across roughly parallel to the uneclipsed lune, with the western edge slightly wider than the eastern. The scene was strikingly beautiful. Only the hill-top we were occupying showed above the fog, as far as could be seen to the south and west, while only Tamalpais showed to the north. There was just enough wind to pile up the upper surface of the fog into big pop-corn like masses, and occasionally send a wisp of it across the summit. It remained about two hundred feet below us until about $11^h\ 45^m$, when it began to blow over in earnest, and we left to catch the last car into Oakland.

ELEMENTS AND EPHEMERIS OF COMET *d*, 1896 (GIACOBINI).

BY F. H. SEARES.

With the help of Mr. CRAWFORD, student assistant in the observatory, I have computed the following elements and ephemeris* for Comet *d*, 1896 (GIACOBINI).

ELEMENTS.

$$T = 1896, \text{ Oct. } 10.3415 \text{ G. M. T.}$$

$$\left.\begin{aligned} i &= 9^\circ\ 6'\ 8'' \\ \omega &= 154\ 47\ 45 \\ \Omega &= 195\ 33\ 58 \end{aligned}\right\} 1896.0$$

$$\log q = 0.046390$$

Residuals for the middle place (O—C).

$$\Delta\lambda \cos\beta = -4''.0;\ \Delta\beta = -4''.0.$$

STUDENTS' OBSERVATORY, Berkeley.

ELEMENTS AND EPEMERIS OF COMET *e*, 1896 (SPERRA).

BY FREDERICK H. SEARES.

"With the assistance of Mr. CRAWFORD, I have computed the following elements and ephemeris† for Comet *e*, 1896 (SPERRA)."

$$T = \text{July } 10.6427 \text{ G. M. T.}$$

$$\left.\begin{aligned} i &= 88^\circ\ 25'\ 12'' \\ \Omega &= 151\ \ 1\ \ 6 \\ \omega &= 40\ 38\ 53 \end{aligned}\right\} 1896.0$$

$$q = 1.139897$$

$$(O-C)\ \Delta\lambda \cos\beta = -0''.7;\ \Delta\beta = +3''.7.$$

STUDENTS' Observatory, University of California, September 14, 1896.

* The ephemeris, at one-day intervals from September 12 to September 24, is omitted here.

† The ephemeris, with four-day intervals from September 14 to September 26, is omitted here.

ELEMENTS OF COMET *e*, 1896.

By W. J. Hussey.

This comet was discovered August 31st by Mr. Sperra, of Randolph, Ohio, and was announced by Mr. William R. Brooks, of Geneva, New York, on September 4th. It was then situated above and near the end of the handle of the Big Dipper in the constellation *Ursa Major*. Its motion was southeasterly, through a region filled with nebulæ, many of which are brighter than the comet. On this account the comet could only be recognized by its motion. From my observations of September 6th, 8th and 11th, I have computed the following elements of its orbit:

$$T = \text{July } 10.41828 \text{ G. M. T.}$$

$$\left.\begin{array}{rl} \omega = & 40^\circ\ 17'\ 38''.0 \\ \Omega = & 150\ \ 59\ \ 47\ .1 \\ \pi = & 191\ \ 17\ \ 25\ .1 \\ i = & 88\ \ 24\ \ 46\ .4 \end{array}\right\} \begin{array}{c}\text{Mean Equinox} \\ 1896.0\end{array}$$

$$\log q = 0.055430$$

Residuals for the middle place:

$$\Delta\,\lambda \cos\beta = +\ 0''.3;\ \Delta\,\beta = +\ 0''.8.$$

It will be seen that the comet is already long past perihelion, and for an object so faint and diffuse, it cannot remain visible very long.

Mount Hamilton, Cal., September 16, 1896.

NOTICES FROM THE LICK OBSERVATORY.

PREPARED BY MEMBERS OF THE STAFF.

LARGE REFRACTOR FOR THE POTSDAM OBSERVATORY.

The dimensions of the new refracting telescope for the Potsdam Observatory are understood to be as follows:

Aperture of the photographic objective, 80 *cm* = 31.5 inches.
Aperture of the guiding telescope objective, 50 *cm* = 19.7 inches.
Length of the tube, 12 — 13 *metres* = 39 — 43 feet.
Diameter of the Dome, about 69 feet.
The Dome is to have a fixed floor. E. S. H.

BRIGHT METEOR SEEN AT OAKLAND, AUGUST 18, 1896.

[Extract from a letter of Mr. ALLEN H. BABCOCK.]

"Last evening, August 18th, at 7:55 P.M., I saw a very bright meteor break or burn up directly below *Cassiopea.* The time is within a half-minute I think. I saw it first just above the "chair" — it passed through the constellation about so —  and at about the head of the arrow it seemed to break up; but the light was so bright that it gave the impression of a sudden enlargement, rather than a breaking up. It disappeared almost immediately after the flare-up, and left a trail which disappeared so quickly that I am not sure whether it was a trail, or the result of the intense light in my own eyes. I did not hear any report."

THE *PERSEIDS* IN AUGUST, 1896.

Although the forerunners of this shower were not very numerous, it was thought advisable to try a photograph of the radiant on the night of August 10th. Therefore a plate was exposed with the CROCKER photographic telescope, using *Eta*

Persei as a guiding star. The plate was exposed from $11^h\ 38^m$ to $14^h\ 49^m$. Only one meteor trail is shown, and that one is faint, about one-half degree long. The position of the center of the trail is approximately $\alpha = 2^h\ 59.7^m$, $\delta = +51^\circ\ 10'$. The time of the meteor's appearance was $11^h\ 57^m\ 43^s$. Several other meteors were timed, some of which were within the field of the plate, but were too faint to leave any trace. This shower seems to have steadily diminished since its maximum in 1894, as there have certainly been fewer this year than in 1895.

A. L. COLTON AND C. D. PERRINE.

MT. HAMILTON, August 23, 1896.

PARTIAL LUNAR ECLIPSE OF AUGUST 22, 1896.

Light clouds interfered somewhat about the time of second contact, but cleared away soon after and remained clear to the end. The first darkening certainly detected was at $8^h\ 35^m$. The Moon entered shadow at $9^h\ 23^m\ 31^s$, and left the shadow at $12^h\ 31^m\ 50^s$ P. S. T. The obscured part of the disc was quite bright, the more prominent markings being easily visible. The Earth's shadow was a bright copper color near the center and shaded to a greenish tinge at the edges. The penumbra showed a light pink color.

C. D. PERRINE.

MT. HAMILTON, August 23, 1896.

ASTEROID No. 341 = *CALIFORNIA*.

Professor MAX WOLF, Director of the Astrophysical Observatory of Heidelberg, has discovered many asteroids, among them No. 341 on September 25, 1892. Wishing to commemorate his visit to our State in 1893, and perhaps desiring to enter a good-humored protest against an article on the Nomenclature of the Asteroids in these *Publications*, Volume VIII, page 28, he has named this planet *California*. Californians will be glad to acknowledge the courtesy of this baptism.

E. S. H.

GIFT OF A PLANE-MIRROR OF SPECULUM METAL TO THE LICK OBSERVATORY BY THE DAUGHTERS OF THE LATE WILLIAM LASSELL, F. R. S.

Through the kindness of the daughters of the late WILLIAM LASSELL, F. R. S., the Lick Observatory is now the possessor of the plane speculum-metal mirror "A" used at Malta with the four-foot reflector. The mirror is oval, about five by seven

inches. A memorandum in Mr. LASSELL'S own handwriting accompanies it, as follows: "Plane speculum A retouched on "Machine, 21st June, 1875. Examined with 3 in. Telescope "and power 115. Defines Dial, name and small figures perfectly. "On distant objects requires the smallest possible lengthening of "focus; therefore slightly convex."

This mirror is a valued addition to our collection, not only for its own excellence, but also as a part of the great reflector constructed by Mr. LASSELL for his second expedition to Malta* which had such a memorable history. EDWARD S. HOLDEN.

LICK OBSERVATORY, August 17, 1896.

ASTRONOMICAL TELEGRAMS.

A telegram was sent to the Harvard College Observatory Friday, August 28th, at 8:05 A.M., to announce that Professor HUSSEY observed a bright prominence on the terminator of *Mars* August 27th, at 16^h 45^m P. S. T.†

ASTRONOMICAL TELEGRAMS *(A Correction).*

In an extract quoted on page 191, No. 50 of these *Publications* from the Report of Mr. TEBBUTT'S Observatory for 1895, the following sentence occurs: "It is much to be regretted that beyond the original announcement of this comet [1895, IV. PERRINE] no further particulars were cabled to Australia."

A letter received from Professor KREUTZ states that this is a mistake, as a second telegram containing very good elements (by Professor LAMP), and a four-day ephemeris from December 13th to December 25th, was sent from Kiel to Melbourne Observatory, the central station for Australia, on the 8th of December. This telegram probably did not reach Mr. TEBBUTT.‡

We cheerfully comply with the request of Professor KREUTZ to publish this explanation, showing that the central station at Kiel was not responsible for the failure in the distribution of this intelligence. THE COMMITTEE ON PUBLICATION.

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*See *Memoirs* R. A. S., Vol. XXXVI, 1867.

†Such prominences were first discovered at the Lick Observatory in 1890, and in 1892 and 1894 they were regularly observed at Mount Hamilton, Nice, and Flagstaff. They have been looked for during August, 1896, and first appeared as above. E. S. H.

‡A late letter from Professor KREUTZ (September 3) notifies that this telegram did not reach Melbourne.

ASTRONOMICAL CABLE-MESSAGES TO THE SOUTHERN HEMISPHERE.

(Dated)
PRIVATE OBSERVATORY, WINDSOR, N.S.W., 1896, August 11.
(Received September 25.)

Sir:

In Volume VIII, page 191 of the *Publications of the Astronomical Society of the Pacific,* I notice the following extract from my Observatory Report for 1895, with reference to the comet discovered by PERRINE: "It is much to be regretted that, beyond the original announcement of the discovery of this comet, no further particulars were cabled to Australia." On June 10 last I received from Dr. KREUTZ of the Royal Observatory, Kiel, a letter stating that the elements and an ephemeris giving the positions of the comet for December 13, 17, 21, 25 were cabled from Kiel to Melbourne on December 8. A warning was also sent to look out for the comet during daylight. On the receipt of this letter, I wrote to Mr. BAUCCHI, the Acting Government Astronomer at Melbourne, and he informed me that, beyond the original announcement giving the position of the comet for November 17 without any indication of the direction of motion, no other message had reached Melbourne from Kiel respecting this comet. It appears, therefore, that neither Kiel nor Melbourne is to blame in this matter, but that the omission is due to some other quarter. As, therefore, you have published the extract from my report, I must ask you, in justice to both Kiel and Melbourne, to publish also this explanation.

I am, Sir, yours faithfully,

JOHN TEBBUTT.

The Secretary of the Astronomical Society of the Pacific,
The Rooms of the Society,
819 Market Street, San Francisco.

ASTRONOMICAL TELEGRAMS.

[COPY.]

(Dated) BOSTON, Sept. 5, 1896.

To Lick Observatory: (Received 1:11 P.M.)

Unlucky GIOCOHINI,* Nice, September author hourhand chattels zero chirleria [*chiberia*] abanicazo abacist.

(Signed) JOHN RITCHIE, Jr.

* Comet *d*, 1896.

Translation of the above.

A comet was discovered by GIACOBINI at Nice September 4.344 G. M. T. R. A. $17^h\ 10^m\ 32^s$, Dec. $-7°\ 29'$. Daily Motions $+1^m\ 44^s$ and $-4'$.

TELEGRAM (*Translation*).

Lick Observatory,
$10^h\ 52^m$ P.M., Sept. 5, 1896.

To Harvard College Observatory:

Comet GIACOBINI was observed by HUSSEY Sept. 5.6804, R. A. $17^h\ 13^m\ 5^s.02$; $\delta\ -7°\ 42'\ 42''$. Cable.

[COPY.]

(Dated) BOSTON, Sept. 6, 1896.

To Lick Observatory: (Received $9^h\ 6^m$ P.M.)

Unlucky BROOKS September atarazana exemplar arlote zero boxthorn easterly. Deimos usual DOUGLASS unbroken.

JOHN RITCHIE, Jr.

Translation of the above.

A comet was discovered by BROOKS* September 4. R. A. $13^h\ 36^m$, $\delta\ +55°\ 40'$, motion easterly. *Deimos* was observed by DOUGLASS September 5.

TELEGRAM (*Translation*).

(Dated) Lick Observatory, Sept. 7.

To Harvard College Observatory: (Sent 9 A.M.)

Comet BROOKS was observed by HUSSEY and PERRINE September 6.8355. R. A. $13^h\ 51^m\ 44^s.1$, $\delta\ +55°\ 24'\ 52''$. Cable.

Comet GIACOBINI was observed by HUSSEY September 6.6916, R. A. $17^h\ 14^m\ 58^s.3$, $\delta\ -7°\ 52'\ 26''$.

TELEGRAM (*Translation*).

(Dated) Lick Observatory, Sept. 7, 1896.

To Harvard College Observatory: (Sent $10^h\ 56^m$ P.M.)

Comet GIACOBINI was observed by HUSSEY September 7.6893 G. M. T., R. A. $17^h\ 16^m\ 54^s.24$, Decl. $-8°\ 2'\ 20''.3$.

---

* Comet *e*, 1896.

TELEGRAM (*Translation*).

(Dated) Lick Observatory, Sept. 9, 1896.

To Harvard College Observatory: (Sent $12^h\ 15^m$ A.M.)

Comet BROOKS (*e*, 1896) was observed by HUSSEY Sept. 8.7176 G. M. T., R. A. $14^h\ 4^m\ 54^s.6$, Decl. $+ 55° 9' 35''.0$.

ASTRONOMICAL TELEGRAMS.

ELEMENTS OF COMET *d*, 1896 (GIACOBINI).

TELEGRAM (*Translation*).

(Dated) Lick Observatory, Sept. 9.

To Harvard College Observatory: (Sent $12^h\ 15^m$ P.M.)

Elements of Comet *d* were computed by HUSSEY and PERRINE as follows:

$$
\begin{aligned}
T &= 1896, \text{ Sept. } 26.88 \text{ G. m. t.} \\
\omega &= 160^\circ\ 33' \\
\Omega &= 191\ \ 40 \\
i &= \ \ 6\ \ 54 \\
q &= 1.0381
\end{aligned}
$$

Elements somewhat uncertain. [They present no resemblance to the elements of any former comet.]

Elements and Ephemeris of Comet d, 1896.

(Dated) BERKELEY, Sept. 10, 1896.

(Received $7^h\ 43^m$ P.M.)

A telegram, as above, was received from Mr. F. H. SEARES, in charge of the Students' Observatory of the University of California, giving elements and ephemeris (Sept. 12–24) of Comet *d*, 1896. The computations were made by Messrs. SEARES and CRAWFORD. The elements will be printed elsewhere in this number.

(Dated) Lick Observatory, Sept. 12.

To Harvard College Observatory: }
To Students' Observatory: } (Sent $8^h\ 25^m$ P.M.)

Comet BROOKS (*e*, 1896) was observed by HUSSEY, September 11.6956 G. M. T., R. A. $14^h\ 25^m\ 39^s.1$; Decl. $+54° 35' 42''.7$.

NOTE.—The first three observations of both Comets *d* and *e*, 1896, were sent by mail or telegraph to the Students' Observatory of the University of California (Mr. F. H. SEARES in charge).

TELEGRAM (*Translation*).

(Dated) Lick Observatory, Sept 11.

To Harvard College Observatory: (Sent 4:05 P.M.)

Elements and Ephemeris of Comet *d*, 1896 (GIACOBINI) were computed by PERRINE as follows:

$$\begin{aligned} T &= \text{September } 27.12 \\ \omega &= 160^\circ\ 51' \\ \Omega &= 191\ \ 38 \\ i &= 6\ \ 56 \\ q &= 1.0320 \end{aligned}$$

[The agreement with the middle observation is exact in longitude, to 1″ in latitude.] The ephemeris from September 12th to September 24th is here omitted.

TELEGRAM.

(Dated) LOS ANGELES, Sept. 21.

(Received $11^h\ 15^m$ A.M. Sept. 21).

Last night at sunset object as bright as *Venus* 1° east of Sun.

L. SWIFT.

TELEGRAM.

(Dated) BOSTON, Sept. 22, 1896.

(Received $7^h\ 35^m$ P.M.)

LEWIS SWIFT announces small bright comet Sunday night [Sept. 20] 1° east of the Sun; Monday, same [?] north brighter.

(Signed) JOHN RITCHIE, Jr.

TELEGRAM (*Translation*).

(Dated) Lick Observatory, Sept. 29.

To Harvard College Observatory: (Sent $8^h\ 20^m$ P.M.)

Comet GIACOBINI was observed by HUSSEY and PERRINE Sept. 28.7156 G. M. T.; R. A. $18^h\ 4^m\ 58^s.7$, Decl. $-11^\circ\ 12'\ 24''$. It is growing fainter.

COMET 1896 (SPERRA).

From the *Science Observer Circular* No. 113, dated Boston, September 12, received by mail at Mount Hamilton, September 19, it appears that Comet *e* was not discovered by BROOKS on September 4 (as announced in the foregoing telegrams) but by SPERRA on August 31. It should therefore be called Comet *d*, and GIACOBINI'S Comet of September 4 should receive the letter *e*. The following paragraph from the *Science Observer Circular* No. 113 contains all the information at present available:

"COMET 1896 (SPERRA).

"The first telegram with reference to this comet was received September 6 from W. R. BROOKS, who announced that he had

seen a comet (probably SPERRA'S) on September 4, in R. A. $13^h\ 36^m$, Decl. + 55° 40′. A letter received at Harvard College Observatory from Allegheny Observatory, states that W. E. SPERRA, of Randolph, O., addressed to Professor KEELER a letter under date of September 1, stating that on August 31, $9^h\ 14^m$, while sweeping through *Ursa Major*, he found a nebulous object west of *Zeta*, in R. A. $13^h\ 8^m\ 25^s$, Decl. + 55° 40′ (1896). Observation during an hour and a quarter showed motion. In a later letter to the same observatory (September 2), Mr. SPERRA gives an observation of September 1, when the comet was in R. A. $13^h\ 14^m\ 30^s$, Decl. + 55° 43′. On September 4, Mr. BROOKS, who had had notice of the discovery, swept through the region and found the comet. Since that time the object has been observed at the Lick Observatory by HUSSEY and PERRINE."

REQUEST FOR OBSERVATIONS OF COMET *b*, (1896) SWIFT.

Having undertaken the computation of the definitive elements of Comet *b*, 1896 (SWIFT, April 13), I shall be very glad to receive any observations of this comet that have not as yet been published.

R. G. AITKEN.

DISTANCES BETWEEN LICK OBSERVATORY AND SAN JOSÉ.

The following distances on the Mount Hamilton road are derived from the readings of a cyclometer attached to my bicycle during a recent ride from the mountain to Oakland (63.7 miles):

	Levels.	Distances.
Lick Observatory,	[4209.5 feet]	0.0 miles
Oh! My! Point,		0.7 "
Tennis Court,		1.8 "
Chinese Camp,		2.7 "
Water-Trough,		3.5 "
Kincaid's Road,		5.5 "
Santa Ysabel Hotel,	[2146.2 feet]	7.0 "
Summit of Grade (into Hall's Valley)		8.- "
Snell's Barn,		11.9 "
Half-Way House,	[about 1540 feet]	12.4 "
Summit of Grade (out of Hall's Valley)	[1838 feet]	14.1 "
Grand View House,	[1500.5 feet]	15.9 "
Junction House,	[389.0 feet]	20.2 "
San José,	[88.7 feet]	—— "

The figures in square brackets are elevations above sea, derived from a survey made by Professor RAYMOND in 1887.

ALLEN H. BABCOCK.

A Bright Meteor Seen September 6, 1896.

A meteor, about as bright as a first magnitude star, having a short, brilliant train, was seen on September 6th, at 7^h 57^m P.M. It appeared close under ϵ *Pegasi*, and moved slowly toward β *Cassiopeiae*, disappearing when about 2° distant from that star. Its flight occupied five or six seconds. R. G. Aitken.

New Short-Period Variable Star in *Gemini*.

[Extract from a Letter from Mr. Edwin F. Sawyer.]

(Dated) Brighton, Sept. 15, 1896.

"* * * In connection with this work, I discovered a few months ago another short-period variable in *Gemini*, with a period of about eight days, and range from 6.8 to 7.6 magnitude. Its position is R. A. 6^h 29^m 14^s; Decl. $+15^\circ$ $24'.8$."

Cost of the Crossley Dome, Etc.

From the ninth annual report of the Director of the Lick Observatory to the President of the University of California, dated September 1, 1896, the following is taken:

The total contributions to the fund for installing the Crossley Reflector at Mount Hamilton amounted to . . . $5085.00.

All of this money has been paid out for materials and labor, according to an itemized account to be printed in the Report of the Secretary of the University for the Fiscal Year ending July 1, 1896.

The Southern Pacific Company transported the heavier parts of the Dome and Telescope from New York to San José free of cost. The value of this service was . . . . . $1005.14.

The Wells-Fargo Express Company transported the mirrors and delicate parts of the apparatus from New York to San José free of cost. The value of this service was . . . . $323.80.

From the annual budget of the Lick Observatory there has been expended for materials and labor the sum of . . $782.17.

72000 brick belonging to the University have been used in the construction of the Dome (at cost, $12 per M.) . $864.00.

The time spent by the observatory workmen on the Crossley Dome and Telescope, if reckoned at their regular rates of pay, would amount to . . . . $1156.33.

Cost of the Bruce Spectroscope: from the fund given by Miss Catherine W. Bruce, $500; from the annual budget of

the LICK Observatory, $175 . . . . $675.00.

Two marble tablets presented by the Vermont Marble Company $50.00

Total cost of bringing the CROSSLEY Reflector and Dome from England and erecting it at Mt. Hamilton . . $9941.44

To this sum must be added the cost (as yet unknown) of providing a new driving-clock for the telescope. This clock is now under construction from designs by Professor HUSSEY.

To commemorate these gifts to the University of California, two tablets of marble will be set up at the main entrance to the CROSSLEY dome, inscribed as follows:

I.

THE CROSSLEY REFLECTOR,
with its Dome, was presented to the LICK Astronomical Department
of the University of California in 1895
by
EDWARD CROSSLEY, F. R. A. S.,
of Halifax, Yorkshire,
England.

II.

The CROSSLEY Reflector was set up in this place by the following friends
of the LICK Observatory:

William Alvord,	Charles Mayne,
T. Ellard Beans,	Albert Miller,
Miss C. W. Bruce,	D. O. Mills,
James V. Coleman,	W. S. Moses,
George Crocker,	Charles Nelson,
Henry J. Crocker,	M. P. O'Connor,
J. B. Crockett,	A. H. Payson,
Christian de Guigné,	Percy & Hamilton,
Mrs. Peter Donahue,	Mrs. John Parrott, Sr.,
J. A. Donohoe,	John Parrott, Jr.,
Farmers' Union,	James D. Phelan,
Glenwood Lumber Company,	William M. Pierson,
Charles Goodall,	James B. Randol,
Robert Y. Hayne,	Louis Sloss,
Alvinza Hayward,	Southern Pacific Company,
I. W. Hellman,	Levi Strauss,
Edward S. Holden,	Lloyd Tevis,
Edward W. Hopkins,	Alex. Blair Thaw,
James F. Houghton,	Union Iron Works,
C. P. Huntington,	United States Express Company,
George R. Lukens,	Wells, Fargo & Company,

The Vermont Marble Company.

MINIMA OF *ALGOL*. R. A. 3^h 1^m 40^s, DECL. $+40°$ $34'.2$, MAGNITUDES 2.3 TO 3.5.

The following times of minima of the variable star *Algol* have been taken from the *Vierteljahrschrift der Astronomischen Gesellschaft*, and are printed here at the request of one of the observers of the Astronomical Society of the Pacific. Times of the minima occurring in daylight have been omitted.

The position for 1900.0 and the magnitudes of maximum and minimum given above have been taken from Dr. CHANDLER'S Third Catalogue of Variable Stars.

Pacific Standard Time.

1896, Oct. 10,	3^h 50^m A.M.	1896, Nov. 2,	2^h 21^m A.M.	1896, Dec. 12,	5^h 45^m A.M.
13,	0 39 A.M.	4,	11 10 P.M.	15,	2 34 A.M.
15,	9 28 P.M.	7,	7 59 P.M.	17,	11 23 P.M.
18,	6 17 P.M.	19,	7 14 A.M.	20,	8 12 P.M.
30,	5 32 A.M.	22,	4 3 A.M.	23,	5 1 P.M.
		25,	0 52 A.M.		
		27,	9 41 P.M.		
		30,	6 30 P.M.		

R. G. AITKEN.

HUBERT A. NEWTON; GEORGE BROWN GOODE; WILLIAM C. WINLOCK;—DIED 1896.

American Science has to lament the loss of three of its representatives. Professor NEWTON, of Yale University, the Dean of American astronomers and mathematicians, for long years an accepted Master, died at New Haven, in August last. Dr. GEORGE BROWN GOODE, Assistant Secretary of the Smithsonian Institution, a leader in his special branch of science, a most willing and efficient helper to the many and varied scientific undertakings which came under his official care, "one of the ablest and best men in America," died in Washington, September 6th, at the early age of forty-five years. WILLIAM C. WINLOCK, a son of a former Director of Harvard College Observatory, Superintendent of Exchanges in the Smithsonian Institution, to whom

every scientific establishment in the wide world owes a debt of gratitude for his care of its interests, died on September 20th, before his time, at the age of thirty-seven years.

Complete memorial notices of all three, to be printed elsewhere, will exhibit their scientific work and service. The present brief note is simply to record the loss to American Science, and to offer here a tribute of sincere affection and respect, based on personal friendships and intimacies extending over a period of more than twenty years, unbroken by a single cloud. No doubt the places of those who are gone can be filled from the crowded ranks of able men who have come from our Universities during the generation just past; but their personalities and their work will not be forgotten. The duties that fell to their lot were performed over long years, under every variety of circumstance, with unvarying ability, fidelity and kindness. In their several ways and degrees, they have left indelible marks on the history of Science in America. Their successors may well take inspiration from their example. EDWARD S. HOLDEN.

MT. HAMILTON, September 30, 1896.

ERRORS OF GRADUATION OF THE REPSOLD MERIDIAN CIRCLE OF THE LICK OBSERVATORY.*

The following set of graduation errors has been determined by means of simultaneous readings of both circles. The instrument is especially adapted to this method, one circle being quickly and conveniently set to any desired reading, with respect to the other.

The agreement of the various measures has been satisfactory; and they afford the means of computing the probable errors of the final values. This has been done, also, by comparison of the results of individual series; and the probable errors are in accord with the quantities to be expected, from the combination of the accidental errors of observation, with the probable errors of the measurements of the gradu ions, used as a standard. For the final corrections, the probable error increases from $\pm 0.''011$ for the divisions best determined, to $\pm 0.''035$ for the corrections to the intermediate 1° arcs.

Each determination rests upon series observed in opposite quadrants, for the elimination of circle flexure. This has, how-

*Abridged from the *Astronomische Nachrichten*, No. 3374. See also these *Publications*, Volume VII, page 330.

ever, been measured, and the corrections are represented by the quantities:

Circle A $+ 0.''08 \sin (R - 315^\circ) + 0.''04 \cos (R - 315^\circ)$
Circle B $+ 0.''02 \sin (R - 315^\circ) + 0.''05 \cos (R - 315^\circ)$

where R is the reading of either circle, at the lower left-hand microscope. The fixed circle reads 315°, when the telescope points to the zenith.

The accompanying table gives the corrections due to graduation, for the mean of four divisions. The measurement has been made from 0° as a base. The mean of the corrections may then be adopted, as the most probable value of the error of 0°; and the column of residuals will represent the actual graduation corrections. The average residual for circle A is $\pm 0''.18$; and the probable error of a circle reading upon four divisions, due to graduation, would be $\pm 0''.15$.

For circle B the average residual is $\pm 0''.15$.

CIRCLE *A*.									CIRCLE *B*.		
		v			*v*			*v*			*v*
0°	0″.00	+0″.18	30°	−0″.18	0″.00	60°	+0″.11	+0″.29	0°	0″.00	+0″.10
1	+0 .09	+0 .27	31	−0 .02	+0 .16	61	−0 .02	+0 .16	3	+0 .19	+0 .29
2	−0 .15	+0 .03	32	−0 .24	−0 .06	62	−0 .19	−0 .01	6	0 .00	+0 .10
3	+0 .22	+0 .40	33	−0 .58	−0 .40	63	−0 .07	+0 .11	9	+0 .04	+0 .14
4	−0 .16	+0 .02	34	−0 .64	−0 .46	64	−0 .16	+0 .02	12	+0 .14	+0 .24
5	−0 .37	−0 .19	35	−0 .86	−0 .68	65	−0 .18	0 .00	15	−0 .29	−0 .19
6	−0 .30	−0 .12	36	−0 .70	−0 .52	66	−0 .12	+0 .06	18	−0 .06	+0 .04
7	−0 .26	−0 .08	37	−0 .44	−0 .26	67	−0 .40	−0 .22	21	+0 .13	+0 .23
8	+0 .04	+0 .22	38	−0 .26	−0 .08	68	−0 .25	−0 .07	24	−0 .05	+0 .05
9	−0 .06	+0 .12	39	−0 .21	−0 .03	69	−0 .33	−0 .15	27	+0 .27	+0 .37
									30	−0 .17	−0 .07
10	−0 .12	+0 .06	40	−0 .41	−0 .23	70	−0 .42	−0 .24	33	−0 .34	−0 .24
11	−0 .08	+0 .10	41	−0 .31	−0 .13	71	−0 .26	−0 .08	36	−0 .44	−0 .34
12	−0 .23	−0 .05	42	−0 .39	−0 .21	72	−0 .40	−0 .22	39	−0 .37	−0 .27
13	−0 .36	−0 .18	43	−0 .46	−0 .28	73	−0 .14	+0 .04	42	−0 .39	−0 .29
14	−0 .46	−0 .28	44	−0 .46	−0 .28	74	+0 .10	+0 .28	45	−0 .07	+0 .03
15	−0 .33	−0 .15	45	−0 .52	−0 .34	75	+0 .09	+0 .27	48	−0 .08	+0 .02
16	−0 .48	−0 .30	46	−0 .22	−0 .04	76	+0 .05	+0 .23	51	−0 .29	−0 .19
17	−0 .50	−0 .32	47	+0 .08	+0 .26	77	+0 .28	+0 .46	54	−0 .28	−0 .18
18	−0 .41	−0 .23	48	+0 .10	+0 .28	78	+0 .12	+0 .30	57	−0 .02	+0 .08
19	−0 .47	−0 .29	49	−0 .04	+0 .14	79	+0 .12	+0 .30	60	+0 .05	+0 .15
									63	−0 .17	−0 .07
20	−0 .19	−0 .01	50	−0 .19	−0 .01	80	−0 .08	+0 .10	66	−0 .22	−0 .12
21	−0 .17	+0 .01	51	−0 .22	−0 .04	81	−0 .02	+0 .16	69	−0 .12	−0 .02
22	−0 .33	−0 .15	52	−0 .38	−0 .20	82	+0 .14	+0 .32	72	−0 .24	−0 .14
23	−0 .19	−0 .01	53	−0 .18	0 .00	83	+0 .25	+0 .43	75	−0 .08	+0 .02
24	−0 .14	+0 .04	54	−0 .16	+0 .02	84	+0 .12	+0 .30	78	+0 .13	+0 .23
25	−0 .23	−0 .05	55	−0 .11	+0 .07	85	0 .00	+0 .18	81	−0 .02	+0 .08
26	−0 .46	−0 .28	56	+0 .06	+0 .24	86	+0 .07	+0 .25	84	−0 .13	−0 .03
27	−0 .22	−0 .04	57	+0 .22	+0 .40	87	−0 .06	+0 .12	87	−0 .03	+0 .07
28	−0 .11	+0 .07	58	+0 .20	+0 .38	88	−0 .22	−0 .04	88	−0 .26	−0 .16
29	−0 .19	−0 .01	59	+0 .02	+0 .20	89	+0 .02	+0 .20	89	−0 .18	−0 .08

Mean 0″.18 Av. ±0″.18 — Mean −0″.10 Av. ±0″.15

This undertaking has been accomplished with the volunteer assistance of Professor R. G. AITKEN, for the simultaneous reading of the circles. No single series has been discarded; but, one series of 45° arcs, and three series of 1° arcs have been repeated, upon indications of larger accidental errors than usual, and the results combined with those of the original series. It has required, for the complete determination, 29,000 microscope readings.

R. H. TUCKER.

WEATHER IN AUGUST, 1896.

A rain-storm with a precipitation of nearly three-tenths of an inch on the night of August 29-30th came as a fitting climax to a most unusual August. Past experience has led to the expectation of the best observing weather of the year during this month; and a few of the earlier nights seemed to justify this expectation, the "seeing" leaving nothing to be desired. But since the tenth there have nine cloudy nights; and an examination of the note-books of the observers shows that on the nights that were clear enough for work, the "seeing" was rated three or less (five representing the best conditions) on twelve nights. On only two nights during the present lunation were the atmospheric conditions good enough to allow the use of the thirty-six-inch refractor for lunar photography. The lower levels of the atmosphere have been filled with haze and smoke due, in great part, to immense forest fires in Washington and in British Columbia.

R. G. AITKEN.

August 31, 1896.

MR. LOWELL ON *MARS*.

The review of Mr. PERCIVAL LOWELL'S book on *Mars*, printed in *Science*, Vol. IV, page 231 (and in these *Publications*, Vol. VIII, page 207) has called out a rejoinder, which is printed in *Science*, Vol. IV, page 358, and a brief reply is to be found in the same journal, Vol. IV, page 455.

THE COMMITTEE ON PUBLICATION.

THE PHOTOGRAPHIC *DURCHMUSTERUNG* OF THE CAPE OF GOOD HOPE OBSERVATORY (DR. DAVID GILL).

"The first volume of the Cape Photographic *Durchmusterung* containing the mean places of 152,000 stars for the Equinox 1875, derived by Professor J. C. KAPTEYN from the Cape Photographs

between the limits of Declination $-19°$ and $-37°$ (both inclusive) has been passed through press. The manuscript of Volume II of the same work, containing the places of 158,000 stars between the limits of Declination $-38°$ and $-52°$ (both inclusive) is ready for press."—From the *Report of H. M. Astronomer at the Cape of Good Hope* for the year 1895.

STAR ATLAS. By WINSLOW UPTON, Professor of Astronomy and Director of the LADD Observatory, BROWN University, Providence, R. I. GINN & Co., Publishers, Boston.

This Atlas is intended for those who wish to become acquainted with the constellations or to find the position of the leading double stars, variable stars, clusters or nebulæ readily visible in small telescopes. It contains large charts of the heavens, with the stars prominently defined and the constellation figures in dim outline, and also auxiliary charts and tables to facilitate the use of the Atlas by teachers and students. E. S. H.

Minutes of the Meeting of the Board of Directors, held at the Lick Observatory, September 5, 1896.

President Hussey presided. A quorum was present. The minutes of the last meeting were approved. The following members were duly elected:

List of Members Elected September 5, 1896.

Mr. J. H. Albert	Salem, Oregon.
Col. Alex. Burton-Brown, R.A., F.R.A.S.	St. George's Club, Hanover Square, London, England.
Miss Grace H. Dodge	262 Madison Avenue, New York, N. Y.
Prof. A. M. Mattoon	Scott Observatory, Parkville, Missouri.
Mr. James K. Moffitt	First National Bank, S. F., Cal.

The following resolution was unanimously adopted by the consenting votes of the Directors, namely: Messrs. Hussey, Holden, Perrine, Molera, Pardee, Edwards, Stringham, Pierson, von Geldern, Ziel, and Miss O'Halloran:

Resolved, That the Treasurer be and he hereby is authorized to withdraw from the Life Membership Fund such sums of money, not to exceed three hundred dollars, as will be necessary to pay the expenses of the General Fund, during the current fiscal year, the sums so withdrawn to be returned to the Life Membership Fund at or before the end of the present fiscal year.

Memorandum on the Distribution of the Publications of the Astronomical Society of the Pacific to Corresponding Institutions, etc.

[Printed by order of the Board of Directors.]

The Astronomical Society of the Pacific was organized February 7, 1889. At a meeting held March 30, 1889, the following resolution was adopted by the Society:

Resolved, That the *Publications* A. S. P. be regularly sent to the following Observatories, etc., and that the Secretaries of the Society be instructed to notify them of this resolution, and to request that they exchange their publications with our own; and that the list of these Corresponding Societies and Observatories be printed in the *Publications* A. S. P.

Accordingly a first list of forty-seven such institutions was printed in Volume I, page 21, and a revised list of ninety-one institutions (authorized by the Directors on July 27, 1889) is given on page 43 of the same volume. At subsequent meetings of the Directors the list was extended and slightly changed.

At a meeting of the Society held January 25, 1890 (see *Publications* A. S. P., Volume II, page 34) Amended By-Laws were adopted, of which Section 5, Article II is:

"A certain number of Observatories, Academies of Science, Astronomical Societies, institutions of learning, etc., not to exceed one hundred, shall be designated by the Board of Directors as Correspond-

ing Institutions, and they shall receive the *Publications* of this Society in exchange or otherwise." The words "or otherwise" it may be well to note, were inserted to authorize the sending of our *Publications* to a few institutions like the Library of Congress, the British Museum, etc., which do not publish books for exchange.

In the list of our members, published each year, the names of Corresponding Institutions have been regularly printed.

From time to time the Directors have authorized the Committee on Publications to exchange the *Publications* for certain scientific journals, etc., regularly sent to the Library of the Society in San Francisco, and also to send a certain number of copies to various periodicals in California for review. Our exchanges with Corresponding Institutions have been regularly sent from Volume I (1889) to and including Volume VII (1895) enclosed in envelopes on which a request for an exchange of publications was printed. At various times the Library Committee has reported that some of the Corresponding Institutions sent their exchanges irregularly or not at all, and on June 8, 1895, the Directors requested the Library Committee to furnish the Secretaries with a list of those Corresponding Institutions which have sent none of their volumes in return for our own. (See *Publications* A. S. P., Volume VII, page 208). Such a list was accordingly prepared, and at a meeting of the Directors on November 30, 1895, it was

Resolved, That any institution that has failed to forward publications in return for those received from this Society is respectfully requested to communicate with the Secretary if a continuance of the interchange of publications be desired. (*Publications* A. S. P., Volume VIII, page 352.)

During January, 1896, the following notice was sent, by order of the President, to some of the Corresponding Institutions:

"Your attention is respectfully directed to the resolution of the Directors printed on page 352 of Volume VII of the *Publications* of this Society for 1895. By order of the President, C. D. PERRINE, F. R. ZIEL, Secretaries."

The returns from this circular have been received. After a consideration of these returns by the Board of Directors it was

Resolved, That the thanks of the Astronomical Society of the Pacific are returned to those Observatories, Scientific Societies, etc., which have enriched its library by exchanges of their publications.

Resolved, That the Board of Directors designate the following Observatories, Academies of Science, institutions of learning, etc., as Corresponding Institutions of the Society, and that the present list supercedes all previous lists.

NOTE.—The list of Corresponding Institutions will be printed with the list of members in January, 1897.

MINUTES OF THE MEETING OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC, HELD AT THE LICK OBSERVATORY, SEPTEMBER 5, 1896.

The meeting was called to order by President HUSSEY. The minutes of the last meeting were approved.

The Secretary read the names of new members duly elected at the Directors' meeting.

The following papers were presented:

1. Observations with a Four-inch Telescope on the Recent Maxima of the Variable Stars R and S *Scorpii*, by Miss ROSE O'HALLORAN.
2. Planetary Phenomena for November and December, 1896, by Professor MALCOLM MCNEILL, of Lake Forest, Illinois.

Adjourned.

OFFICERS OF THE SOCIETY.

W. J. Hussey (Lick Observatory), ... *President*
E. J. Molera (606 Clay Street, S. F.) . . . . } *Vice-Presidents*
E. S. Holden (Lick Observatory), ... }
O. von Geldern (819 Market Street, S. F.) . . . . . }
C. D. Perrine (Lick Observatory), ... *Secretary*
F. R. Ziel (410 California Street, S. F.), ... *Secretary and Treasurer*

Board of Directors—Messrs. Edwards, Holden, Hussey, Molera, Miss O'Halloran, Messrs. Pardee, Perrine, Pierson, Stringham, von Geldern, Ziel.

Finance Committee—Messrs. von Geldern, Pierson, Stringham.

Committee on Publication—Messrs. Holden, Babcock, Aitken.

Library Committee—Miss O'Halloran, Messrs. Molera, Burckhalter.

Committee on the Comet-Medal—Messrs. Holden (*ex-officio*), Schaeberle, Campbell.

OFFICERS OF THE CHICAGO SECTION.

Executive Committee—Mr. Ruthven W. Pike.

OFFICERS OF THE MEXICAN SECTION.

Executive Committee—Messrs. Camilo Gonzalez, Francisco Rodriguez Rey.

NOTICE.

The attention of new members is called to Article VIII of the By-Laws, which provides that the annual subscription, paid on election, covers the *calendar* year only. Subsequent annual payments are due on January 1st of each succeeding calendar year. This rule is necessary in order to make our book-keeping as simple as possible. Dues sent by mail should be directed to Astronomical Society of the Pacific 819 Market Street, San Francisco.

It is intended that each member of the Society shall receive a copy of each one of the *Publications* for the year in which he was elected to membership and for all subsequent years. If there have been (unfortunately) any omissions in this matter, it is requested that the Secretaries be at once notified, in order that the missing numbers may be supplied. Members are requested to preserve the copies of the *Publications* of the Society as sent to them. Once each year a title-page and contents of the preceding numbers will also be sent to the members, who can then bind the numbers together into a volume. Complete volumes for past years will also be supplied, to members only, so far as the stock in hand is sufficient, on the payment of two dollars to either of the Secretaries. Any non-resident member within the United States can obtain books from the Society's library by sending his library card with ten cents in stamps to the Secretary A. S. P., 819 Market Street, San Francisco, who will return the book and the card.

The Committee on Publication desires to say that the order in which papers are printed in the *Publications* is decided simply by convenience. In a general way, those papers are printed first which are earliest accepted for publication. It is not possible to send proof sheets of papers to be printed to authors whose residence is not within the United States. The responsibility for the views expressed in the papers printed rests with the writers, and is not assumed by the Society itself.

The titles of papers for reading should be communicated to either of the Secretaries as early as possible, as well as any changes in addresses. The Secretary in San Francisco will send to any member of the Society suitable stationery, stamped with the seal of the Society, at cost price, as follows: a block of letter paper, 40 cents; of note paper, 25 cents; a package of envelopes, 25 cents. These prices include postage, and should be remitted by money-order or in U. S. postage stamps. The sendings are at the risk of the member.

Those members who propose to attend the meetings at Mount Hamilton during the summer should communicate with "The Secretary Astronomical Society of the Pacific" at the rooms of the Society, 819 Market Street, San Francisco, in order that arrangements may be made for transportation, lodging, etc.

PUBLICATIONS ISSUED BI-MONTHLY.

(February, April, June, August, October, December.)

KEPLER.

PUBLICATIONS

OF THE

Astronomical Society of the Pacific.

VOL. VIII. SAN FRANCISCO, CALIFORNIA, DECEMBER 1, 1896. NO. 53.

KEPLER.

BY EDWARD S. HOLDEN.

JOHN KEPLER was born, December 27, 1571, at Magstatt, in Wurtemburg. He was a feeble child, with weak vision. His family, though very poor, had pretentions to nobility, as one of his ancestors had been made knight by the Emperor SIGISMUND (1411–1437) at Rome. Young KEPLER was sent to school at the age of six years, but was soon removed, in order to become waiter in an inn. The father, who had been a soldier in the Belgian war, now engaged in the Austrian army sent against the Turks, and was not again heard from. The mother, whose youth had been spent with an aunt who had been burned as a witch, was extravagant and unkind, and KEPLER'S youth was most unhappy. His two brothers were good-for-naughts, and his only consolation was the tender friendship of his sister Marguerite, who was married to a Protestant pastor, and in him, also, KEPLER had an enemy. At eighteen years of age, the boy was sent to the seminary at Tuebingen, where he did not greatly distinguish himself. The influence of the celebrated MAESTLIN turned KEPLER'S thoughts from theology to mathematics.

"As soon as I could appreciate the charms of philosophy," says KEPLER, "I followed it with ardor, in all its parts. I gave no particular attention to astronomy, though I readily comprehended what was taught. I had been educated at the expense of the Duke of Wurtemburg, and when I saw my schoolmates accept positions in his service for which they had shown no especial aptitudes, I decided to take the first place which might be offered to me." This position was that of professor of astronomy.

At the age of twenty-two years (1593), KEPLER was appointed professor at Graz. In 1600 the religious persecutions in Styria broke out; and KEPLER, with his fellow professors, who were Protestants, was expelled. In 1597 he had married a noble and very beautiful widow, with whom his life was not happy.

In the same year (1600) TYCHO BRAHE called KEPLER to Prague as his assistant. KEPLER'S first letters from Prague contain this paragraph: "All is uncertain here. TYCHO is a man with whom one cannot live without being exposed to cruel insults. The salary is splendid, but the treasury is empty, and no one is paid." At TYCHO'S death (1601), KEPLER was appointed court-astronomer at a salary of fifteen hundred florins, which, likewise, was not paid. "I waste my time," says KEPLER, "at the door of the treasurers and in begging." One thing consoled him for all these troubles. This was the free access to the manuscript astronomical observations of TYCHO, and the opportunity to seek in them the secrets of the planetary motions. Not the least of his annoyances was the necessity to cast horoscopes for the court officials. After the death of the Emperor RODOLPH his successor appointed KEPLER to reform the calendar, which was rejected as "Papist" by Protestants. Although an official of the court, KEPLER was obliged to earn his bread by calculating little almanacs containing weather and other prognostics. The arrears of his salary amounted, at this time, to twelve thousand crowns. He now accepted the chair of mathematics at Linz, and (his wife having died) he married the beautiful SUSANNE RETTINGER, by whom he had seven children. His happiness was of short duration. He was accused of heresy by the Catholics and by the Protestants of Linz at once.

In 1615 KEPLER'S sister writes to beg his aid in the lawsuit instituted against his mother as a sorceress. This suit continued for five years. His mother, then seventy-five years old, was accused of having been instructed in magic by an aunt who had in fact been burned for sorcery; of having bewitched various persons; of having conversation with the Devil; of being unable to weep; of causing the death of the pigs of the neighborhood; and finally, of never looking one in the face—a habit of witches, it was averred. KEPLER was able to modify the sentence of his mother, not to annul it. She was released, and died in 1622. On his return to Linz his enemies so reviled him as the son of a sorceress, that it was necessary for him to leave Austria.

He became astronomer to WALLENSTEIN, but was replaced by the Italian astrologer, ZENO, after having vainly begged for the arrears of his salary. He died at the age of fifty-nine years, November 15, 1630. He left behind him twenty-two crowns, a coat, two shirts, twenty-seven copies of his *Ephemerides*, and sixteen copies of his *Rudolphine Tables*. At the time of his death, the princes whom he had served were in his debt twenty-nine thousand florins.

These melancholy details give KEPLER'S biography a place in the martyrology of Science.* The world in general recollects only the brilliant series of achievements which it owes to him; and does not remember the misery and trouble which continuously surrounded his life. These tribulations were desperately real to him, and it is an injustice to a heroic soul to forget that the discoveries which have changed the face of the world's thought, were wrung from cruel and sordid circumstance.

II. PORTRAIT OF KEPLER.

The portrait of KEPLER accompanying this article is copied from a photograph kindly given to me many years ago by Dr. J. L. E. DREYER, Director of the Observatory of Armagh. It is a copy of an original painting now, I believe, in the possession of KEPLER'S descendants, and, so far as is known, has never before been published.

III. JUDICIAL ASTROLOGY.

A short account of judicial astrology will not be unwelcome here.

The twelve "*houses*" of astrology were thus defined: Imagine a sphere surrounding the Earth and concentric with it, on which meridians (called *circles of position*) are drawn from its north to its south pole† thirty degrees apart, dividing the surface into twelve equal parts. Each of these areas is a "*house*," according to the terms of judicial astrology.

The *house* just about to rise at the moment for which the horoscope was cast is I — the first house. The lower meridian of the

* The foregoing sketch is chiefly taken from ARAGO, *Oeuvres*, tome iii, p. 198.

† Sometimes the great circles were drawn through the north and south poles of the ecliptic, more often through the north and south points of the horizon. At least three different systems were thus available to the astrologer, who could choose the one which served his purpose (and his client) best.

place separates the third and fourth *houses;* VI has just set; the upper meridian of the place separates IX and X; XII has just risen.

Each star and planet is situated in some one of the *houses*. The stars revolve in circles parallel to the equator, as do the planets; but the latter have motions along the ecliptic, within the Zodiac. The auguries depended chiefly on the positions of the planets in the Zodiac, and in respect to the various *houses*. The most important house was the first — the *ascendant*, — *i. e.*, that one just about to rise. The point of the ecliptic just rising was the the *horoscope* — a term which has gradually been transferred to the augury itself. The X *house* — that just east of the meridian and approaching it — was next in power, etc. Moreover, each *house* had a special meaning:

I	is the	house of	*Life;*	VII	is the	house of	*Marriage;*
II	"	"	*Riches;*	VIII	"	"	*Death;*
III	"	"	*Brethren;*	IX	"	"	*Religion;*
IV	"	"	*Parents;*	X	"	"	*Dignities;*
V	"	"	*Children;*	XI	"	"	*Friends;*
VI	"	"	*Health;*	XII	"	"	*Enemies.*

Each *house* (and also each sign of the Zodiac) has a planet for its Lord. The Sun has his throne in *Leo;* the Moon, in *Cancer; Mercury*, in *Virgo; Venus*, in *Taurus; Mars*, in *Scorpio; Jupiter*, in *Sagittarius; Saturn*, in *Aquarius;* etc.

When any planet is in its own *house* its influence is greater than in any other situation; if a planet is in a powerful *house* — in the ascendant, for example, — its influence is stronger than if it were in a weaker one — that near the lower-meridian, for instance, — the III, and so on.

The planets were related to persons, countries, conditions, etc. somewhat as follows: The Sun referred to the persons of kings, emperors, and high dignitaries; the Moon, to those of lower degree, especially to such as plied their avocations by night; *Mercury* was the planet of philosophers, astrologers,* poets; *Venus* was related to love, marriage, women, as was but fitting; *Mars* was the soldier's planet; *Jupiter*, the planet of sages; *Saturn* ruled the fates of the aged, of monks, etc. Again, the Sun was beneficent; the Moon, melancholy; *Mercury*, inconstant; *Venus*, gracious; *Mars*, ardent; *Jupiter*, benign; *Saturn*, morose.

Not only were the planets efficient in human affairs by their

* N. B. the seal of the Astronomical Society of the Pacific.

very nature, as well as by their positions in the celestial *houses*, but also by their positions with respect to each other — their *aspects*. The *aspect* was the angle between two lines drawn from two planets to the earth's centre. *Mars* was in *opposition* to *Jupiter* when the two radii made an angle of 180°; in *conjunction*, when the angle was 0°; in *trine*, at 120°; in *quadrature*, at 90°; etc.

Quadrature and opposition were unfavorable portents; conjunction was neither favorable nor otherwise; trine and sextile were fortunate aspects.

It is not difficult to refute the pretensions of Astrology; and the wonder is that they endured so long. Two persons born at the same time (and at or near the same place*) should have the same fate. Paris in the time of CATHERINE DE MEDICIS or LOUIS the Eleventh was sufficiently populous to have suggested this obvious conclusion, which, just as obviously, was not in accord with experience. The king and the carpenter, born in the same hour, had very different lives; but the carpenter had no astrologer to cast *his* horoscope — and the king believed that the stars revolved for him alone.

The deathblow to astrology was given by the system of COPERNICUS, which changed the face of the world. When it was once clearly understood † that the Earth was a planet like *Mars* or *Mercury*, it took a new place in the solar system and in men's thoughts. *Jupiter* no longer moved in order to influence the destiny of the insignificant inhabitants of another planet. It had a mission of its own. Man was dethroned, and could no longer regard himself as the centre of the universe.

IV. ON A MANUSCRIPT OF KEPLER'S.

A short while ago a manuscript of KEPLER'S was offered for sale in Germany, and it was at once secured for the collection of the LICK Observatory. ‡ It is from the collection of KEPLER MSS. of the Observatory of Pulkowa, and bears the certificate of W. STRUVE. §

It is written on both sides of a rough, strong piece of paper,

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* For the latitude influenced the *horoscope*.

† Not until after the discoveries of GALILEO with the telescope had proved the conclusions of COPERNICUS to be true.

‡ MSS., letters, etc., of BESSEL, GAUSS, HANSEN, C. A. F. PETERS, SCHUMACHER, W. STRUVE, and others have been obtained for the Observatory.

§ "Die Uberschrift von fremder Hand, das uebrige von KEPLER'S Hand. Aus der Sammlung der KEPLER'schen Manuscripte in Pulkowa. W. STRUVE.

"Pulkowa, den 25/13 Mai 1854."

about six by eight inches. The ink is somewhat yellow and faded, but is entirely legible. The MS. is a horoscope, cast by KEPLER, of one HANS HANNIBAL HÜTTER, who was born 1586, September 10th. It bears the marks of extreme haste. At first sight, one might think that some other piece of manuscript would be more desirable for the collection of an astronomical observatory. What value could be assigned, for instance, to the scrap of paper on which the master verified his guess as to the third law of motion? But nothing is more suitable to recall the personality of KEPLER than this piece of astrology, by means of which he kept the wolf from the door, and purchased the strength and leisure for higher things.

It is strange to reflect that, at last, this portrait and this manuscript of KEPLER'S should be printed for the first time in these *Publications*, on the very borders of BALBOA'S Sea!

The chief parts of the manuscript are as follows:

First—The title (which was not written by KEPLER):

> *Anno 1586 den 10 Tag Septemb... und*
> *5 uhr nachmittags Ist Hannss Hannibal*
> *Hütter Von Hutterss..en,*
> *Zur Welt geboren. h?*

Then follows, on the same side of the paper, a diagram by KEPLER, intended to give the XII astrological *houses*. It is not quite in the usual form, and has evidently been drawn in great haste. Next the diagram are eleven lines, in a column, giving the *aspects*, etc., of the planets and Moon.

On the reverse side of the sheet are five columns, similar to that just described: the first, of 14 lines; the second, of 16 (some of which should have been written in the third column, as is indicated by lines directed to their proper places); the third, of 8 lines (this column relates to the situation of the signs of the Zodiac, and is surrounded by a border); the fourth, of 15 lines; the fifth, of 16 lines.

As the only interest in the manuscript is derived from KEPLER'S connection with it (the fate of HANS HANNIBAL HÜTTER being now unimportant), I do not transcribe the separate symbols here. The essential point is that the LICK Observatory possesses a genuine manuscript in KEPLER'S hand which illustrates a part of his real life and belief.

There is no doubt that KEPLER seriously studied the art and

science of judicial astrology, nor that he (like his forerunner, TYCHO,) gave it a certain credence, always accompanied with some doubt.

"Wahrlich in aller meiner Wissenschaft der Astrologie weiss ich nit so viel Gewissheit, dass ich einzige Specialfach mit Sicherheit duerfte vorsagen."*

LICK OBSERVATORY, October 19, 1896.

(TWENTY-FOURTH) AWARD OF THE DONOHOE COMET-MEDAL.

The Comet-Medal of the Astronomical Society of the Pacific has been awarded to Mr. W. E. SPERRA, of Randolph, Ohio, for his discovery of an unexpected comet on August 31, 1896.

The Committee on the Comet-Medal,

EDWARD S. HOLDEN,
J. M. SCHAEBERLE,
W. W. CAMPBELL.

October 31, 1896.

(TWENTY-FIFTH) AWARD OF THE DONOHOE COMET-MEDAL.

The Comet-Medal of the Astronomical Society of the Pacific has been awarded to Mr. GIACOBINI, of the Observatory of Nice, France, for his discovery of an unexpected comet on September 4, 1896.

The Committee on the Comet-Medal,

EDWARD S. HOLDEN,
J. M. SCHAEBERLE,
W. W. CAMPBELL.

November 4, 1896.

* WOLF: *Geschichte der Astronomie*, page 286.

RESULTS OF DOUBLE-STAR MEASURES, MADE AT THE LICK OBSERVATORY.

BY R. G. AITKEN.

Below are given the results of my measures of double-stars during the past year. The details of the measures will be found in the *Astronomische Nachrichten.*

Unless otherwise indicated in the notes, each result given is the mean of three nights' measures, usually with the twelve-inch equatorial, though some of the closer pairs were measured on one night with the thirty-six-inch.

No.	Double Star.	R. A. 1880.	Decl. 1880.	Position Angle.	Distance.	Magnitudes.	1895 +	Notes.
		h. m. s.	° ′	°	″			
1	β 391	0 3 14	−28 39	271.0	0.93	6.5 - 6.5	.83	
2	H 1964	0 19 32	−19 29	115.7	6.60	7 - 10	.93	
3	H 1968, AB	0 21 33	−17 4	106.7	2.81	7 - 10½	.93	
	AC			122.2	93.55	- 11½	.93	
4	Σ 35	0 25 27	− 2 43	266.8	8.55	9+ - 9+	.92	
5	Σ 42 AC	0 29 38	+29 21	199.0	38.17	8 - 10+	.96	
6	Σ 44	0 31 56	+40 20	266.3	9.52	8+ - 9+	1.04	
7	Σ 45	0 32 7	+46 18	88.0	11.79	7 - 10	1.04	
8	OΣ 18 AB	0 36 11	+ 3 31	129.2	1.15	7+ - 9+	1.45	
	AC			269.2	42.99	- 12+	1.45	
9	Σ 53 rej.	0 37 18	− 1 33	335.0	26.54	8+ - 10	1.11	
10	Σ 63	0 43 56	+11 11	227.6	17.12	8+ - 11+	1.07	
11	Σ 69	0 47 51	+83 2	13.5	23.41	8+ - 9+	0.96	
12	H 1057	0 50 6	+37 51	122.0	36.69	4 - 11+	1.04	*μ Andromedæ.*
13	H 1068	0 58 44	+14 18	262.9	55.24	6 - 11+	1.13	*72 Piscium.*
14	H 634	1 4 36	+ 8 55	266.5	37.41	6+ - 11	1.13	
15	β 1029 BC	1 7 27	+ 6 56	241.5	0.97	5 - 13	1.74	*ζ Piscium.*
	AB=Σ100			63.5	23.72	4 - 5	1.73	2 nights.
16	H 2061	1 30 2	−18 8	321.0	65.59	7+ - 9+	1.13	
17	Σ 142	1 33 28	+14 39	339.7	15.56	8+ - 8+	1.08	
18	Σ 143	1 33 32	+33 44	319.2	35.62	7+ - 9	1.04	
19	Σ 149	1 37 24	+39 21	95.7	1.11	8+ - 9+	1.10	
20	Σ 197	1 53 59	+34 43	232.3	24.89	7+ - 8+	1.05	
21	Σ 357	3 2 34	−13 3	295.2	7.96	8+ - 10+	1.17	4 nights.
22	Σ 358	3 2 44	− 4 9	347.9	15.42	8+ - 11+	1.16	
23	Σ 343	3 4 38	+83 37	324.8	27.09	8+ - 9	1.56	
24	H 663	3 6 37	− 1 39	249.8	4.60	6 - 11	1.19	2 nights. *94 Ceti*
25	H 1133	3 8 35	+69 19	202.5	30.58	6 - 12	1.35	
26	Σ 418	3 30 52	+75 0	63.3	19.08	8 - 9	1.35	2 nights.
27	Σ 436	3 35 11	−13 0	235.5	36.13	7 - 8	1.14	
28	OΣ 65	3 43 6	+25 13	198.1	0.72	6.5 - 7	1.44	4 nights.
29	Σ 475	3 52 3	− 7 28	19.2	7.39	8+ - 10	1.14	
30	Σ 486	4 0 42	+79 11	341.2	9.03	9+ - 10+	1.45	

No.	Double Star.	R. A. 1880.	Decl. 1880.	Position Angle.	Distance.	Magnitude.	1895 +	Notes.
		h. m. s.	° ′	°	″			
31	OΣ 74	4 5 41	+ 9 21	294.2	0.33	8 - 8+	1.72	36-inch.
32	Σ 505	4 6 41	+62 17	115.7	9.17	8+ - 11	1.71	
33	β 547	4 7 25	+ 8 58	353.4	0.91	5½ - 9	1.70	4 nights.
34	H VI 101	4 18 33	+17 38	232.8	77.41	4.0 - 9	1.16	δ *Tauri.*
35	H 3664	4 29 56	−25 17	192.1	21.61	7+ - 10	1.16	
36	Σ 596	4 40 15	−12 10	288.1	10.19	8 - 10	1.16	
37	Σ 620	4 51 32	+13 46	231.2	3.64	8+ - 9	1.16	
38	Σ 634	5 2 47	+79 5	12.3	14.75	5 - 8+	1.27	
39	Σ 629	5 4 4	+83 14	2.0	15.27	8 - 11	1.27	
40	Σ 651	5 4 14	− 7 13	47.4	19.55	8 - 10	1.15	2 nights.
41	OΣ 103	5 10 17	+33 14	54.6	3.80	5 - 11+	1.31	*16 Aurigæ.*
42	OΣ 104	5 14 12	+46 54	189.2	17.53	7+ - 11	1.29	
43	Σ 704	5 20 48	+69 34	12.8	21.58	7+ - 9	1.30	
44	Σ 736	5 28 36	+41 45	350.2	2.58	7+ - 8+	1.26	2 nights.
45	Σ 770	5 34 30	+19 9	334.2	1.20	8+ - 10	1.18	
46	Σ 771	5 34 41	+19 31	234.7	24.12	9 - 9	1.18	
47	Σ 1455 A & BC	10 39 11	+86 24	246.0	33.75	8 - 9+	1.43	
	BC			348.6	1.95	10 - 10	1.43	
48	S 615	10 42 18	−14 1	1.1	86.34	9 - 10	1.43	2 nights.
49	Σ 1471	10 43 0	+80 26	0.1	2.06	9 - 9	1.49	
50	β 915	10 43 13	+24 55	231.2	1.26	9 - 9	1.52	2 nights.
51	Σ 1554	11 29 55	+13 31	252.0	0.95	8 - 8+	1.50	4 nights.
52	Σ 1555	11 29 59	+28 27	344.0	0.60	6+ - 6+	1.44	
53	Σ 1561	11 32 29	+45 46	259.6	10.03	6+ - 7+	1.40	
54	OΣ 239 rej.	11 37 59	+25 53	20.6	37.78	5½ - 10	1.40	
55	β 795 AB	11 53 51	+71 20	328.0	14.39	8 - 12+	1.43	
	CD			114.0	6.25	8 - 12	1.43	
56	β 920	12 9 34	−22 41	244.0	0.84	6+ - 8	1.52	1 night.
57	Σ 1621	12 9 54	+ 6 19	136.2	2.54	9 - 10	1.45	
58	β 796	12 11 19	+ 7 16	260.0	0.66	8 - 9	1.52	
59	S 643	12 47 40	−17 23	294.5	23.40	8 - 9	1.43	
60	H 1222	12 47 40	+47 26	Star	single		1.47	36-in. 1 night.
61	β 341	12 57 19	−19 56	307.9	0.78	6+ - 6+	1.54	2 nights.
62	Σ 1715	12 58 9	+20 2	229.1	7.26	8+ - 9+	1.48	
63	β 799	13 1 7	+73 40	245.3	0.83	7 - 8+	1.71	
64	OΣ 261	13 6 4	+32 43	347.2	1.61	7 - 7+	1.48	
65	β 221	13 6 54	−14 49	45.6	1.34	8 - 9	1.49	
66	β 222	13 10 55	−20 54	14.8	1.51	8 - 9	1.48	
67	H 529	13 13 59	+35 47	120.4	17.30	9 - 10	1.51	
68	Ho. 260	13 18 0	+29 51	314.7	0.80	8+ - 8+	1.48	
69	β 113	13 23 9	+12 6	203.8	1.32	8 - 10	1.50	
70	OΣ 269	13 27 26	+35 32	214.1	0.4	6½ - 7	1.53	36-in. 2 nights.
71	Σ 1757	13 28 9	+ 0 18	72.4	2.50	8 - 9	1.43	
72	Σ 1761	13 29 2	+72 20	71.6	20.38	8½ - 9	1.64	
73	β 937	13 51 52	+35 1	102.8	0.88	8 - 8+	1.49	
74	OΣ 277	14 7 6	+29 17	354.6	0.81	8 - 8	1.49	

No.	Double Star.	R. A. 1880.	Decl. 1880.	Position Angle.	Distance.	Magnitude.	1895 +	Notes.
		h. m. s	° ′	°	″			
75	Σ 1816	14 8 36	+29 40	79.0	1.66	7+ - 7+	1.49	2 nights.
76	β 414	14 34 42	—30 25	346.5	0.90	6+ - 8	1.49	4 nights.
77	β 31	14 46 59	+19 13	192.1	1.57	8+ - 10	1.46	
78	β 618 A & BC	15 5 23	—19 20	111.0	58.23	5 - 10	1.44	*i Libræ.* 2 nts.
	BC			19.1	1.68	10 - 10	1.46	4 "
79	Σ 1950	15 24 50	+25 55	90.2	3.23	7 - 9	1.62	
80	β 945	15 26 9	+57 51	30.8	15.68	6+ - 12	1.48	
81	OΣ 297	15 29 40	+25 25	142.8	5.55	7½ - 11½	1.51	
82	β 620	15 38 54	—27 41	170.2	0.72	7 - 7+	1.49	1 night.
83	Σ 1969	15 39 1	+60 22	49.1	0.80	8 - 9	1.64	
84	Σ 2026	16 10 5	+ 7 41	267.7	0.71	8+ - 9	1.53	
85	A.G. Berlin, 5594	16 18 46	+20 40	112.4	5.06	7 - 10+	1.47	A new pair.
86	OΣ 311	16 22 33	+21 10	198.6	7.12	7½ - 10	1.47	
87	β 416	17 10 47	—34 51	314.8	1.45	6 - 8	1.44	*B.A.C. 5825.*
88	Σ 2272	17 59 23	+ 2 33	291.3	2.40	3 - 6	1.51	*70 Ophiuchi.*
89	OΣ 342	18 1 42	+ 9 33	Star	round		1.50	3 nights. 36-in.
90	β 826	18 2 5	+ 9 45	331.5	0.71	9½ - 9½	1.70	36-inch.
91	AC 15	18 2 26	+30 33	310.3	0.84	6 - 10½	1.70	4 nights. 36-in. *99 Herculis.*
92	Σ 2281	18 3 36	+ 3 58	231.5	0.19	6 - 7	1.70	*73 Ophiuchi.* 2 nights. 36-in.
93	Σ 2294	18 8 25	+ 0 9	94.2	0.16	7+ - 7+	1.64	36-inch.
94	β 760 AB	18 9 31	—36 48	101.2	3.65	3+ - 11+	1.46	*η Sagittarii.*
	AC			276.2	33.34	3+ - 13	1.48	2 nights. 36-in.
	AD			303.8	93.14	3+ - 9+	1.47	
95	Σ 2400 AB	18 43 32	+16 7	184.2	2.17	8 - 11	1.54	36-inch.
	AC			188.3	3.15	8 - 10	1.54	36-inch.
	BC			197.2	0.94	11 - 10	1.54	36-inch.
96	β 648	18 52 30	+32 45	231.5	1.34	6 - 9+	1.49	
97	Σ 2434 AB	18 56 34	— 0 53	126 3	23.59	8 - 8+	1.49	
	BC			53.8	1.12	8+ - 10	1.49	
98	HN 129	18 57 0	—23 5	307.7	8.14	7 - 8+	1.62	1 night. 36-in.
99	HN 126	18 57 10	—21 43	317.5	0.44	7 - 8+	1.73	2 nights. 36-in.
100	Σ 2673-74 AB	20 17 6	+12 57	330.5	2.64	8 - 9+	0.85	
	CD			359.8	15.95	8 - 11	0.85	
	AC			103.6	75.65		0.85	
101	*a Cygni*	20 37 20	+44 51	106.6	75.72	- 11	0.92	
102	OΣ 413	20 42 44	+36 3	60.7	0.62	5 - 6	1.54	*λ Cygni.*
103	A.G.C. 13	21 10 0	+37 32	333.6	0.79	4 - 9+	1.55	*τ Cygni.*
104	β 989	21 39 12	+25 6	93.7	0.09	5 - 5+	1.68	4 nights. 36-in *κ Pegasi.*
105	β 172	22 17 52	— 5 27	7.3	0.57	5½ - 5½	0.83	*51 Aquarii.*
106	OΣ 536	22 52 29	+ 8 43	166.8	0.21	7.4 - 7.5	1.73	*B.A.C. 8001.* 36-inch.
107	Σ 2912	22 23 54	+ 3 49	294.1	0.28	6 - 7	1.66	*37 Pegasi.* 36-inch.
108	β 1154	23 53 12	+74 10	308.0	0.77	8 - 8+	0.91	

NEW ELEMENTS AND EPHEMERIS OF COMET *e*, 1896, (GIACOBINI).

By F. H. Seares.

From the Lick Obervatory observations of September 5th, 11th, and 28th, Mr. Crawford and I have deduced improved elements of Comet Giacobini. The elements are considerably different from our first set, and show how very nearly indeterminate a first solution would necessarily be.

Our results are:

$$T = \text{Oct. } 18.91806 \text{ G. M. T.}$$

$$\left.\begin{array}{rl} i = & 12^\circ\ 20'\ \ 0''.0 \\ \Omega = & 186\ \ 15\ \ 44\ .0 \\ \omega = & 136\ \ 10\ \ \ 6\ .1 \end{array}\right\} \text{Mean equinox of 1896.0.}$$

$$\log q = 0.208244$$

Residuals for the middle place (O — C):

$$\Delta\lambda \cos \beta = -\ 5''.9;\ \Delta\beta = -\ 20''.6.$$

[The ephemeris, at four-day intervals, from October 14th to the 26th, is here omitted.]

Students' Observatory, Berkeley, Cal., October 9, 1896.

ELLIPTIC ELEMENTS OF COMET *GIACOBINI.*

By W. J. Hussey and C. D. Perrine.

From Mt. Hamilton observations of September 5th, 11th, and 28th, we have computed the following elliptic elements of this comet:

Epoch: 1896, Sept. 5.5, Gr. M. T.

$$M = 354^\circ\ 43'\ 37''$$

$$\left.\begin{array}{rl} \Omega = & 191\ \ 44\ \ 13 \\ \omega = & 139\ \ \ 5\ \ 28 \\ i = & 11\ \ 35\ \ 18 \end{array}\right\} \text{Mean ecliptic and equinox of 1896.0.}$$

$$\log e = 9.82189$$

$$\log a = 0.64636$$

$$\log \mu = 2.58047$$

$$\text{Period} = 9.323 \text{ years.}$$

The same observations are also satisfied by the following remarkable system of elements:

$$\begin{array}{rl} \text{Epoch:} & \text{1896, Sept. 0.0, Gr. M. T.} \\ M = & 286^\circ\ 26'\ 48'' \\ \Omega = & 216\ \ 34\ \ 53 \\ \omega = & 190\ \ 49\ \ 45 \\ i = & \ \ 7\ \ 34\ \ 29 \\ \log e = & 9.29718 \\ \log a = & 0.09470 \\ \log \mu = & 3.40796 \\ \text{Period} = & \text{506 days.} \end{array} \left.\begin{array}{l} \\ \\ \\ \\ \end{array}\right\} 1896.0.$$

The last elements, however, do not satisfy later observations.

MT. HAMILTON, CAL., October 13, 1896.

PLANETARY PHENOMENA FOR JANUARY AND FEBRUARY, 1897.

By PROFESSOR MALCOLM MCNEILL.

JANUARY, 1897.

Mercury is in good position for observation until after the middle of the month. It reaches its greatest eastern elongation on January 6th, and for the first two weeks of the month it remains above the horizon from an hour and a half to an hour after sunset. It then approaches the Sun very rapidly and passes inferior conjunction on January 22d.

Venus is very conspicuous in the evening sky in the southwest, three to four hours behind the Sun in its daily path. It moves northeastward among the stars, about thirty-five degrees, from the eastern part of the constellation *Capricorn* through *Aquarius* into *Pisces*.

Mars is still a fine object, and is above the horizon nearly the whole night. It is in the constellation *Taurus*, nine degrees north and a little east of the first magnitude star *Aldebaran* (α *Tauri*). Its apparent motion among the stars is very small, less than two degrees. It retrogrades (moves westward) until January 15th, and then moves eastward again, its position at the end of the month being about the same as at the beginning. Its

actual distance from the Earth is increasing very rapidly, and on January 31st it is about 110,000,000 miles away. Although still quite bright, it has lost a considerable fraction of the light it gave us at opposition.

Jupiter is getting into position for evening observation again, rising at half-past nine on January 1st, and two hours earlier on January 31st. It is in the eastern part of the constellation *Leo*, about ten degrees east and south of *Regulus* (*α Leonis*), and during the month it moves about two degrees westward and northward toward that star.

Saturn is a morning star rising at about 4 A.M. on January 1st, and a little after 2 A.M. on January 31st. It is on the border of the constellations *Libra* and *Scorpio;* and during the month it moves not quite three degrees eastward and southward.

Uranus is in the same neighborhood with *Saturn*, and moves in the same direction, but only about half as fast. At the beginning of the month it is about two degrees nearly due south from *Saturn*.

Neptune is in the eastern part of *Taurus*, and is above the horizon nearly the entire night, but it cannot be seen without a telescope.

FEBRUARY, 1897.

There will be an *annular eclipse of the Sun* on February 1st. The path of the central eclipse lies mainly in the southern Pacific Ocean, the line extending from a point near New Zealand to the northern part of South America, crossing a little south of the Isthmus of Panama and ending just off the north coast. It will be visible as a partial eclipse late in the afternoon in the eastern and southern part of the United States.

Mercury is a morning star throughout the month, and reaches greatest west elongation on February 15th. During the greater part of the month the conditions for visibility in the early twilight are good.

Venus is still an evening star, and reaches greatest east elongation on the morning of February 16th. It sets nearly four hours later than the Sun. It moves about thirty degrees eastward and northward during the month in the constellation *Pisces*. It is very near the vernal equinox, about seventeen minutes north, at 5 A.M., February 2d, P. S. T.

Mars is still in good position for observation, not setting until

long after midnight. It is in the constellation *Taurus*, and moves about ten degrees eastward during the month. Its distance from the Earth is increasing, but not quite as rapidly as during January, and on February 15th it is just about as far away from us as is the Sun.

Jupiter is above the horizon nearly all night and comes to opposition on February 23d. It moves about four degrees westward and northward toward *Regulus*, the chief star in the constellation *Leo*, and is about six degrees from that star at the end of the month.

Saturn rises two hours earlier than during the corresponding period of January. It is in the constellation *Scorpio* and moves about one degree eastward during the month; at the end of the month it is a about one degree west and one degree north of the third magnitude star β *Scorpii.*

Uranus follows about two degrees west and one degree south of *Saturn.* Its motion is, however, much slower, and it nearly stops before February 28th.

Neptune is about stationary in the eastern part of the constellation *Taurus.*

Explanation of the Tables.

The phases of the Moon are given in Pacific Standard time. In the tables for Sun and planets, the second and third columns give the Right Ascension and Declination for Greenwich noon. The fifth column gives the local mean time for transit over the Greenwich meridian. To find the local mean time of transit for any other meridian, the time given in the table must be corrected by adding or subtracting the change per day, multiplied by the fraction whose numerator is the longitude from Greenwich in hours, and whose denominator is 24. This correction is seldom much more than 1^m. To find the standard time for the phenomenon, correct the local mean time by *adding* the difference between standard and local time if the place is west of the standard meridian, and *subtracting* if east. The same rules apply to the fourth and sixth columns, which give the local mean times of rising and setting for the meridian of Greenwich. They are roughly computed for Lat. 40°, with the noon Declination and time of meridian transit, and are intended as only a rough guide. They may be in error by a minute or two for the given latitude,

and for latitudes differing much from 40° they may be several minutes out.

PHASES OF THE MOON, P. S. T.

		H. M.
New Moon,	Jan. 2,	10 3 P. M.
First Quarter,	Jan. 10,	1 46 P. M.
Full Moon,	Jan. 18,	12 17 P. M.
Last Quarter,	Jan. 25,	12 9 P. M.

THE SUN.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Jan. 1.	18 50	−22 58	7 27 A.M.	12 4 P.M.	4 41 P.M.
11.	19 33	−21 43	7 26	12 8	4 50
21.	20 16	−19 47	7 22	12 12	5 2
31.	20 58	−17 13	7 14	12 14	5 14

MERCURY.

Jan. 1.	20 8	−21 54	8 40 A.M.	1 22 P.M.	6 4 P.M.
11.	20 47	−17 36	8 23	1 22	6 21
21.	20 23	−16 7	7 15	12 19	5 23
31.	19 43	−18 10	6 2	10 59 A.M.	3 56

VENUS.

Jan. 1.	21 46	−15 19	9 53 A.M.	3 0 P.M.	8 7 P.M.
11.	22 30	−10 48	9 42	3 5	8 28
21.	23 12	− 5 52	9 28	3 8	8 48
31.	23 52	− 0 46	9 10	3 8	9 6

MARS.

Jan. 1.	4 45	+25 23	2 23 P.M.	9 57 P.M.	5 31 A.M.
11.	4 39	+25 12	1 39	9 12	4 45
21.	4 39	+25 9	1 0	8 33	4 6
31.	4 44	+25 12	12 26	7 59	3 32

JUPITER.

Jan. 1.	10 48	+8 50	9 33 P.M.	4 4 A.M.	10 35 A.M.
11.	10 47	+9 2	8 52	3 23	9 53
21.	10 45	+9 19	8 9	2 41	9 13
31.	10 41	+9 43	7 26	1 59	8 32

Saturn.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Jan. 1.	15 42	−17 36	3 58 A.M.	8 57 A.M.	1 56 P.M.
11.	15 45	−17 47	3 23	8 21	1 19
21.	15 49	−17 56	2 48	7 45	12 42
31.	15 52	−18 3	2 11	7 8	12 5

Uranus.

Jan. 1.	15 41	−19 23	4 5 A.M.	8 56 A.M.	1 47 P.M.
11.	15 43	−19 29	3 27	8 18	1 9
21.	15 44	−19 34	2 49	7 40	12 31
31.	15 46	−19 38	2 11	7 2	11 53

Neptune.

Jan. 1.	5 10	+21 30	3 5 P.M.	10 22 P.M.	5 39 A.M.
11.	5 9	+21 29	2 25	9 42	4 59
21.	5 8	+21 29	1 45	9 2	4 19
31.	5 7	+21 28	1 5	8 22	3 39

Eclipses of *Jupiter's* Satellites, P. S. T.

(Phenomena are seen near left-hand limb of planet as seen in an inverting telescope.)

		H. M.			H. M.
I, D,	Jan. 1.	8 42 P. M.	I, D,	Jan. 17.	6 56 P. M.
II, D,	1.	9 10 P. M.	I, D,	23.	2 21 A. M.
I, D,	7.	4 6 A. M.	II, D,	23.	4 59 A. M.
I, D,	8.	10 35 P. M.	I, D,	24.	8 49 P. M.
II, D,	8.	11 46 P. M.	II, D,	26.	6 17 P. M.
I, D,	14.	6 0 A. M.	III, D,	28.	7 11 P. M.
I, D,	16.	12 28 A. M.	I, D,	30.	4 15 A. M.
II, D,	16.	2 22 A. M.	I, D,	31.	10 43 P. M.

Minima of *Algol*, P. S. T.

	H. M.		H. M.
Jan. 1.	7 24 A. M.	Jan. 18.	12 18 P. M.
4.	4 13 A. M.	21.	9 7 A. M.
7.	1 2 A. M.	23.	5 56 A. M.
9.	9 51 P. M.	26.	2 45 A. M.
12.	6 40 P. M.	29.	11 34 P. M.
15.	3 29 P. M.		

PHASES OF THE MOON, P. S. T.

		H. M.
New Moon,	Feb. 1,	12 13 A. M.
First Quarter,	Feb. 9,	11 25 A. M.
Full Moon,	Feb. 17,	2 11 A. M.
Last Quarter,	Feb. 23,	7 44 A. M.

THE SUN.

1897.	R. A. H. M.	Declination. ° ′	Rises. H. M.	Transits. H. M.	Sets. H. M.
Feb. 1.	21 2	− 16 56	7 13 A.M.	12 14 P.M.	5 15 P.M.
11.	21 42	− 13 50	7 2	12 14	5 26
21.	22 20	− 10 21	6 52	12 14	5 36
Mar. 3.	22 58	− 6 36	6 34	12 12	5 50

MERCURY.

Feb. 1.	19 42	− 18 22	5 58 A.M.	10 54 A. M.	3 50 P.M.
11.	19 56	− 19 39	5 38	10 29	3 20
21.	20 40	− 19 1	5 40	10 33	3 26
Mar. 3.	21 35	− 16 14	5 45	10 48	3 51

VENUS.

Feb. 1.	23 56	− 0 15	9 8 A.M.	3 8 P.M.	9 8 P.M.
11.	0 34	+ 4 50	8 49	3 6	9 23
21.	1 9	+ 9 42	8 30	3 3	9 36
Mar. 3.	1 42	+ 14 8	8 8	2 56	9 44

MARS.

Feb. 1.	4 45	+ 25 13	12 23 P.M.	7 56 P.M.	3 29 A.M.
11.	4 55	+ 25 22	11 53 A.M.	7 27	3 1
21.	5 9	+ 25 32	11 26	7 1	2 36
Mar. 3.	5 25	+ 25 40	11 3	6 38	2 13

JUPITER.

Feb. 1.	10 41	+ 9 46	7 21 P.M.	1 54 A.M.	8 27 A.M.
11.	10 36	+ 10 13	6 36	1 11	7 46
21.	10 31	+ 10 43	5 50	12 27	7 4
Mar. 3.	10 26	+ 11 12	5 0	11 38	6 16

Saturn.

1897.	R. A. H. M.	Declination. ° '	Rises. H. M.	Transits. H. M.	Sets. H. M.
Feb. 1.	15 52	− 18 4	2 8 A.M.	7 5 A.M.	12 2 P.M.
11.	15 54	− 18 9	1 30	6 27	11 24 A.M.
21.	15 55	− 18 12	12 53	5 50	10 47
Mar. 3.	15 56	− 18 12	12 14	5 11	10 8

Uranus.

Feb. 1.	15 46	− 19 38	2 9 A.M.	6 59 A.M.	11 49 P.M.
11.	15 47	− 19 41	1 30	6 20	11 10
21.	15 47	− 19 43	12 52	5 42	10 32
Mar. 3.	15 47	− 19 44	12 13	5 3	9 53

Neptune.

1897.	R. A. H. M.	Declination. ° '	Rises. H. M.	Transits. H. M.	Sets. H. M.
Feb. 1.	5 7	+ 21 28	1 1 P.M.	8 18 P.M.	3 33 A.M.
11.	5 6	+ 21 28	12 21	7 38	2 55
21.	5 6	+ 21 28	11 41 A.M.	6 58	2 15
Mar. 3.	5 6	+ 21 29	11 2	6 19	1 36

Eclipses of *Jupiter's* Satellites, P. S. T.

(Phenomena are seen close to left-hand limb, as seen in an inverting telescope before opposition February 23d; after that near right-hand limb.)

		H. M.			H. M.
I, D,	Feb. 2.	5 12 P. M.	III, D,	Feb. 12.	3 7 A. M.
III, D,	4.	11 10 P. M.	I, D,	15.	2 30 A. M.
I, D,	6.	6 8 A. M.	I, D,	16.	8 58 P. M.
I, D,	8.	12 36 A. M.	II, D,	17.	2 6 A. M.
IV, D,	9.	12 9 A. M.	IV, R,	25.	10 31 P. M.
I, D,	9.	7 4 P. M.	II, R,	27.	8 49 P. M.
II, D,	9.	11 30 P. M.			

Minima of *Algol*, P. S. T.

	H. M.		H. M.
Feb. 1.	8 23 P. M.	Feb. 19.	1 17 A. M.
4.	5 12 P. M.	21.	10 6 P. M.
7.	2 1 P. M.	24.	6 55 P. M.
10.	10 50 A. M.	27.	3 44 P. M.
13.	7 39 A. M.		
16.	4 28 A. M.		


J. Sykora


Lappland

THE TOTAL ECLIPSE OF AUGUST 9, 1896.

By Alexander Rydzewski.

The Russian Astronomical Society organized two expeditions for observing the total eclipse of the Sun of August 9th of this year. One was stationed at the village of Tshekurskoje on the Lena, near Olekminsk, in Siberia, and another at Siikavuopio,* on the right (Swedish) bank of the river Muonio. At first the society intended to send the last expedition to Iitto, a little village on the left bank of the Muonio in Finnish Lapland; but the difficulties of transporting the luggage of the expedition to this place, and also the shorter distance of Siikavuopio from the line of central eclipse, forced a change in the first plan.

Thinking that it will be interesting to the members of the Astronomical Society of the Pacific to learn some particulars of the expedition to Siikavuopio, I intend, as a member of this expedition and also as a member of the A. S. P., to give a brief sketch of our journey to Siikavuopio, and of our observations during the eclipse.

The *personnel* of this expedition was as follows: L. G. Wuchikhowsky, an experienced astronomer, who possesses an observatory at Belkawe, near Winzig, in Silesia; I. I. Sycora, an astronomer from Charkow, whose last paper, concerning the variability of the Sun's diameter, was remarked by the scientific world; General-Lieutenant Baron N. W. Kaulbars; and myself.

The expedition possessed the following instruments: (1) seven-inch Merz telescope, equatorially mounted, moved by hand, and with a revolving camera, the system of which was proposed by the Russian physicist, W. W. Lermantoff; (2) four-inch Merz lens, loaned to the expedition by the Board for providing Russian state papers, with a photographical camera attached to it, equatorially mounted, and also moved by hand; (3) 2.4-inch Fraunhofer's telescope; (4) 1.8-inch Steinheil's and Zeiss' photographic lens, with camera; (5) a photographic apparatus with film-ribbons for sixty-four photographs, loaned to Baron N. W. Kaulbars, by the photographical firm Nyblin, in Helsingfors; (6) 1.2-inch Kern's universal instrument for determining geographical positions; (7) Frodsham mean-time

* The coördinates of the station were: Longitude, 1h 26m 37s E.; Latitude, 68° 37′ 27″.

chronometer; (8) ERICSON mean-time chronometer; (9) WIREN mean-time chronometer (of decimal system); (10) FRODSHAM sidereal-time chronometer; (11) an aneroid by NODÉ, loaned to the expedition by General A. A. TILLO; (12) a STEPHAN'S compass; (13) a PISTOR and MARTIN'S reflecting-circle, with an artificial mercurial horizon.

We left St. Petersburg (Messrs. WUCHIKHOWSKY, SYCORA, and myself), after making all the necessary preparations, July 8th, at 9 o'clock A.M., by the Finland railway, and at 9 o'clock P.M. of this day at the railway station, Richimiaki, we met the fourth member of our expedition, Baron N. W. KAULBARS, who came from Helsingfors.

The railway journey to Oulu (Swedish Uleaborg) was very pleasant and comfortable. I cannot omit here to mention the courtesy of the Senate of Finland, who arranged for a free passage for all the members of the expedition, and for free transport of the astronomical and domestic luggage. We arrived at Oulu on July 9th, at 9 o'clock P.M. The Sun at this hour of the day was yet high, and illuminated the very pretty but small town of Oulu, which is situated on the shore of the Gulf of Bothnia. This town, notwithstanding its smallness (it has only 10,000 inhabitants), is illuminated by electric light, and has the telephone also. In the United States that is not a rare thing, but here much larger towns have neither telephone nor electric light.

We left Oulu by the steamship "Pahjola," July 10th, at half-past six in the morning. The day was fine and sunny; no wave disturbed the smooth surface of the Gulf of Bothnia. After twelve hours' journey, we arrived at Tornea, a little town which belongs to Finland, and is situated on an island near the mouth of the river Torneo, in the Gulf of Bothnia. Opposite, on the right coast of Torneo, is situated the Swedish town Haparanda, known to all the world as one of the most northern meteorological observatories ($+ 65^\circ 50'$ latitude). At Torneo we spent two days in making astronomical observations for geographical position, and we left this town, July 9th, at nine o'clock in the evening. Our carriages were a kind of dog-carts, mostly used in Finland, but not very convenient for transporting a luggage so bulky as our instruments. In these dog-carts we made our journey to Kolari during three nights; traveling at night because the days were too hot. During the daytime we slept at very pretty and clean post-stations.

July 13th, about eleven o'clock in the evening, we passed near the mountain Avasaksa, which is yearly visited about the twenty-first of June by innumerable tourists from different parts of the world, coming here to observe the Sun, which does not set during three days about this date. Although Avasaksa is situated south of the polar circle, its height (172 metres) compensates for the difference of latitude. The road from Torneo to Kolari is very hilly, and the constant climbing and descending wearied our horses immensely. As an additional annoyance we were attacked by an innumerable army of mosquitoes, about whose ferocity in this country we had heard before starting from home.

The fifteenth of July, we came to Kolari, a little village on the shore of the river Muonio. From this place our journey to Siikavuopio, the final point of our voyage, had to be made in boats. On the morning of July 16th, all the boxes containing our instruments and equipment were loaded into boats—six in all; after that we placed ourselves in the boats, on the boxes, and commenced our long journey on the river Muonio. The unusual mode of traveling requires a detailed description of the boats themselves, as well as of the mode of propulsion. The flat-bottomed boats are about eight yards long, one yard wide, and the distance between the gunwale of the boat and the surface of the water, when the boat was loaded, was only three and a half inches. The boats are propelled by three boatmen, one on the prow and two on the poop, who move the boat against the current by means of pushing-poles three and a half yards in length. This mode of propulsion is particularly difficult in the rapids, which on the Muonio river were encountered by dozens every day. In these places our boatmen were so tired by propelling the boats, that they were literally soaked with perspiration, and after an hour's hard work they were obliged to rest and to renew their strength with coffee. Muonio's shores are very picturesque, particularly near the rapids, but the flora is not rich; the pine disappears totally by the village Ilimuonio (latitude 68° 0′), the fir by Kuttainen (latitude 68° 23′); in the more northern parts of Lapland the wiry birches of small size are the sole representatives of trees. We encountered during our journey very few polar reindeer, although they are quite common in that country; they are usually sent in summer by their owners to graze in the mountains. The weather during our journey

through Muonio was variable; sometimes it rained the whole day, sometimes the Sun burned us from morning till night, when we stopped for rest in the very clean and comfortable villages situated on the shores.

July 24th, the last day of our journey to Siikavuopio, was very cold. The wind was blowing from the mountains, which were covered in several places with snow lying in the hollows; where it never melts, not even in the midst of summer. We came to Siikavuopio the same day at 6 o'clock P.M., and at once selected a suitable place for observing the coming eclipse: it was the hill Siikavaara, whose height is about ninety-five yards above the level of Muonio, situated about a mile from our lodging in Siikavuopio. We could not begin the installation of the instruments at once for want of wood for making supports, and we were obliged to wait till it was brought from a locality farther south. In the mean time Mr. SYCORA observed the Sun near the meridian and near the prime vertical, and I computed immediately from his observations the latitude and the corrections of the chronometer; Baron KAULBARS made a detailed plan of Siikavuopio, with its neighborhood; and Mr. WUCHIKHOWSKY arranged the photographic dark-room and adjusted his telescope to photographic focus by taking several photographs of the Moon. At last the wood arrived at Siikavuopio, and we began to make the necessary installation of the instruments.

The meridian lines for all the instruments were determined by the Sun: all our astronomical observations in Siikavuopio were made by the Sun, because our universal instrument was so small that no star, even of the first magnitude, could be seen with it on such a bright sky as that of Siikavuopio till the middle of August, when even at midnight the Sun is only 7° $30'$ below the horizon.

On August 5th all was ready, and on August 6th, at the same hour at which the eclipse would occur on August 9th, we made at Siikavaara a rehearsal of our coming observations. On this day, at 4 o'clock A.M., when we started from our lodging to Siikavaara, there was a frost, the only one experienced during our sojourn in Lapland.

The weather in Lapland is very variable, which, I suppose, can be explained by its position directly in the path of cyclones traversing Europe towards the northeast; but, on the whole, fine weather prevails there. It is a pity that no meteorological observatory is established in this region (neither in Sweden nor

in Finland), and therefore we have no regular records of the weather in this part of Lapland.

The eve of the long-expected day was rainy, and we lost all hope of seeing the eclipse; but in the evening the weather began to improve. The clouds broke in several places, which constantly grew, and with their growing we began to have more hope. We went to sleep at eleven, but, as is easily conceived, we could not sleep, and we skipped from our beds every ten minutes to see if the heavens were clearing or not.

At 2 o'clock A. M., of August 9th, we were already up, and started at once for our observatory on Siikavaara.

The sky to the north and northeast, and particularly at the place where the observations were to be made, was quite clear, although the rest of the sky was covered with small passing clouds. We were joined on the mountain by all our boatmen and by all the inhabitants of Siikavuopio, so that the people on the mountain, during the eclipse, amounted to one-and-thirty men and three women in all. There never were before, and there never will be again, so many people in such a wild region as Siikavaara. We placed ourselves beside our instruments: Mr. WUCHIKHOWSKY at the seven-inch MERZ photographic telescope, Mr. SYCORA at the four-inch photographic MERZ telescope.* Baron KAULBARS prepared himself for photography with two cameras (without equatorial mounting), and I stood beside the 2.4-inch FRAUNHOFER telescope to make by its help a drawing of the corona and the prominences.

This was not the first eclipse observed by Baron KAULBARS, Mr. WUCHIKHOWSKY, and myself. We had been participants in different expeditions organized by Russia in 1887 for observing the eclipse of August 19th; but the weather then had been unfavorable for the former two gentlemen. I had been lucky enough to belong to the party of Professor GLASENAPP, who secured observations on the line of central eclipse, at a little town, Petrowsk, where the weather was more propitious. Although the sky was covered with clouds, it was yet possible to observe the corona through them, because they were sufficiently thin.

At 4^h 27^m 0^s (M. S. T.) the first contact took place, and the Sun began rapidly to disappear behind the Moon. No such

*To that telescope the spectroscope and another four-inch telescope for eye observations were attached; but Mr. SYCORA had no time during the short duration of the eclipse to make observations other than photographic.

strange and beautiful coloring of the clouds as I had remarked during the eclipse of 1887 was observed before totality. Several seconds before the second contact, Mr. WUCHIKHOWSKY cried "Beads," but they were seen by no other member of the party.

At $5^h\ 21^m\ 39^s$ (M. S. T.) the totality began, but no trace of the corona was seen in the field of my telescope. Thinking I had moved the telescope. I gazed at the sky with the naked eye and immediately saw the extremely bright corona, and when I looked again in the telescope the corona was just in the middle of the field of view. The corona appeared smaller and not so bright as viewed with the naked eye, but its particularities were very well seen, on the other hand. Five large prominences (one of them double) of a light rose tint surrounded the very dark body of the Moon; two of the prominences were mountain-like, three column-like, one of the last being double. The top of the higher of the two was curved to the north. At the northwest of the corona I observed one coronal streamer; one at the east; and one at the southeast. The radial structure of these streamers was very evident, whilst at the eclipse of 1887 no such structure could be observed at Petrowsk. The color of the corona was silver-white, with no greenish tinge such as has been observed during some eclipses by several astronomers; nor was a greenish tinge seen during the eclipse of 1887. Several seconds before third contact, which was at $5^h\ 23^m\ 20^s$ (M. S. T.) the chromosphere appeared, and soon after that the first ray of the Sun flashed out, and the sublime spectacle was ended. It had lasted one hundred and one seconds.

Twenty-two photographs of the corona and of the crescent Sun were obtained before the totality and during it: Mr. WUCHIKHOWSKY photographed five coronas and four crescents; Mr. SYCORA, three coronas and three crescents; and Baron KAULBARS (with two cameras), three coronas and four crescents. On several photographs of Sun's crescents made by Mr. WUCHIKHOWSKY a thin mist encircling the crescent is to be observed; but it was so thin that none of us observed it either with telescopes or with the naked eye. I suppose that this mist was due to the rapid falling of the temperature, which led to the condensation of the moist air just in the path of the cone of shadow.

The temperature before the first contact of the eclipse was 4° C.; ten minutes after that contact it fell to 3° C.; during the totality the thermometer was not observed, but as the tempera-

ture ten minutes after totality was only 2° C., it may be supposed that during the totality it was not higher than 1° C.

Thinking that the readers of this brief description of the eclipse of August 9th will be interested in seeing the photographs and the drawing of the corona, I add to my article five illustrations of the corona:

(1) One of four seconds exposure, photographed with the seven-inch telescope by Mr. WUCHIKHOWSKY.*

(2) Two photographed with the four-inch telescope by Mr. SYCORA; one of fifteen seconds of exposure, another of twenty seconds.*

(3) One with landscape, photographed with the ordinary photographic camera by Baron KAULBARS.

(4) My drawing of the corona, as observed by the 2.4-inch telescope.*

To illustrate our observatory, and our instruments, I add also a photograph of the top of the mountain, Siikavaara, taken by Mr. WUCHIKHOWSKY, about an hour after the totality.

The same day most of our photographic plates were developed by Mr. WUCHIKHOWSKY; the development of the remaining plates was put off until our return to St. Petersburg.

We left Siikavuopio August 12th, after our bulky luggage was packed.

The return homewards was far swifter than our journey to Siikavuopio, because the current of Muonio, and particularly its rapids, helped us, now, instead of hindering as was the case before.

On August 20th, we parted with Baron KAULBARS at Richimiaki; Mr. WUCHIKHOWSKY left us at Perkijarvi; and Mr. SYCORA and myself arrived together the same evening at St. Petersburg. Such was the end of our interesting and fortunate expedition (compared with the unlucky expeditions to Vadsö and Japan) to Lapland, which was carried out in such friendly company as can never be forgotten by me.

ST. PETERSBURG, October 7th, 1896.

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* See the plate accompanying.

CATALOGUE NO. I, OF NEBULÆ DISCOVERED AT THE LOWE OBSERVATORY, CALIFORNIA, FOR 1900.

BY DR. LEWIS SWIFT, Director.

Since the removal of my astronomical instruments from the Warner Observatory, at Rochester, N. Y., to the Lowe Observatory, Echo Mountain, Cal., I have, besides entertaining visitors, devoted much time to comet-seeking, with my 4½-inch, and as a pastime, that an old habit may not entirely languish, have also at odd spells continued my former work of searching for new nebulæ, resulting in the following list. My low latitude + 34° 20′, enables me to work in fields beyond the reach of Sir WILLIAM HERSCHEL, or of his son Sir JOHN, except while sojourning at the Cape of Good Hope. Scarcely any of these nebulæ can be classified as bright, and but very few are of HERSCHEL'S Class II, while the large majority are much fainter than his Class III, and therefore visible only during exceptionally fine seeing, with large telescopes, and by an eye long trained in this kind of work.

The eye-piece used is a periscopic by the GUNDLACH Optical Co. of Rochester, N. Y., giving a magnifying power of 132 and a field of 32′. Its large flat field renders it admirably adapted for nebular work, and for comet-seeking it cannot be excelled.

No.	DATE.	h m s	° ′ ″	DESCRIPTION.
1	Sept. 12,'96	0 1 40	− 4 19 10	pB. vS. vE.
2	Dec. 8,'95	0 18 3	+ 6 25 35	eeF. unequal D*f 46s same parallel.
3	Sept. 10,'95	0 30 0	− 10 7 0	eeeF. pS. R. eedif.
4	Sept. 5,'96	0 38 30	− 4 41 53	eeF. S. R. 10ᵐ * close s. Not 239.
5	Sept. 18,'95	0 53 22	− 12 43 17	eeF. pS. nearly bet. a 7ᵐ * p & a 9ᵐ * nf. near the latter.
6	Dec. 13,'95	0 56 40	− 16 9 6	pF. S. R. 9ᵐ * nearly in contact np.
7	Oct. 6,'96	1 12 45	− 17 38 12	eF. 8ᵐ * in field nf. p S. R. no * near.
8	Dec. 18,'95	1 14 20	− 17 22 28	vF. pS. lE. wide D* near nf. f of 2.
9	Dec. 18,'95	1 14 40	− 17 37 25	eeF. vS. R. p a 7ᵐ * nf. 47ˢ· p of 2.
10	Oct. 12,'96	1 20 30	+ 16 4 42	eeeF. pS. lE. bet. 2*'s in meridian, wide D star in field nf. eedif.
11	Oct. 8,'96	1 43 10	− 27 26 42	pB. eeS. almost stellar, in vacancy.
12	Dec. 8,'95	1 46 45	− 10 20 0	eeF. vS. G. C. 418 p.
13	Dec. 18,'95	1 55 5	− 11 36 25	eeF. pS. bet. the 2 southern of 4 stars forming a trapezium.

No.	Date.	h m s	° ′ ″	Description.
14	Oct. 8,'96	1 56 8	−25 34 40	eeeF. pS. R. 3 9^m *'s near sf. form an equilateral triangle, eedif.
15	Oct. 8,'96	2 2 55	−25 57 32	vF. D * in neb'y, both *'s = m. but of extreme faintness—Curious object.
16	Oct. 12,'96	2 11 20	−12 24 55	eeF.eeE.bet.2*'s p&f.8^m * near nf. a ray.
17	Oct. 12,'96	2 27 50	−37 11 40	vF. S. R. wide D * near np.
18	Sept. 16,'96	3 0 20	−27 52 35	eeF. vS. R. F* near sf.
19	Oct. 8,'96	3 5 8	−25 42 30	eeF. pS. 2 stars in meridian close p.
20	Oct. 8,'96	3 36 45	−22 55 35	vF. pS. R. Not G. C. 765.
21	Oct. 5,'96	3 37 1	−18 32 20	eeF. S. R. in vacancy.
22	Oct. 5,'96	3 51 1	−28 30 25	eF. vS. eeeF * v close nf.
23	Dec. 10,'95	4 10 32	−33 22 25	eeef. eS. B * f. 1532 p. eedif. 3 in field including D neb.
24	Dec. 9,'95	4 23 3	−42 23 15	eF. pL. R. 3 stars like belt of Orion point to it, p of 2.
25	Oct. 5,'96	4 41 2	−34 10 43	vF. pS. R. 3 stars in line near sp. nearly point to it.
26	Oct. 13,'96	5 27 30	−23 14 40	eF. pL. R. 8^m * near nf.
27	Oct. 16,'96	5 27 40	−17 20 3	pF. vS. R. bet. 2 stars p & f.
28	Dec. 9,'95	5 29 35	−26 30 45	vF. pS. eE. almost a ray 963 p.
29	May 26,'95	15 15 10	−23 19 50	eeeF. vL. not 5898 nor 5903 vdif. bet. 2 wide D *'s n&s. 10^m * eef. no * in field p.
30	Aug. 12,'96	20 58 49	+11 25 15	eeeF. vS. p 8^m * 13^s same parallel, wide D * nr n. eedif.
31	Sept. 12,'96	21 25 40	+11 20 15	eeF. vS. F* near f. Not 7068.
32	Aug. 8,'96	22 15 19	−14 54 5	vF. eE. a ray, p of 2.
33	Aug. 8,'96	22 16 30	−19 25 20	eeeF. vS. R. f below * 15^s little s. f of 2.
34	June 8,'96	22 16 45	−19 23 20	eF. S. nr n of fol * of 7 in a line p&f. p of 2.
35	Aug. 8,'96	22 26 54	−14 38 5	pB. pS. R. pB * near s. f of 2.
36	Sept. 12,'96	22 49 10	−20 55 15	eeeF. pL. R. f 9^m * 22^s eedif.
37	Sept. 2,'96	22 51 5	−37 8 48	vF. S. eeE. a ray s. p of below stars. sf of 2.
38	Sept. 2,'96	22 51 10	−37 3 45	B. Cl. R. bet 2 *'s p & f, np of 2.
39	Sept. 2,'96	22 52 0	−36 27 40	vF. ps. R. np of 2.
40	Aug. 12,'96	22 52 5	−36 37 40	vF. pS. vE. sf of 2.
41	Aug. 12,'96	22 53 40	−38 17 50	vF. Cl. lE, 2 wide D stars near p.
42	Sept. 10,'96	23 5 30	−33 5 15	a few eeeF stars in neb.
43	Sept. 13,'96	23 21 0	−18 36 0	eF. vS. R. F * p close np.
44	Sept. 14,'96	23 24 10	−29 25 57	eeeF. S. vE. 8^m * p.
45	Sept. 14,'96	23 41 40	−28 32 55	eeeF. eS. R. 9^m * near f, same parallel, 1st of 5.
46	Sept. 14,'96	23 42 0	−28 42 16	eeF. S. R. a 6^m * with dis com. f, 2nd of 5.
47	Sept. 14,'96	23 42 5	−28 42 56	eeF. S. R. 3rd of 5.
48	Sept. 14,'96	23 42 20	−28 43 55	eF. pS. E. 4th of 5.
49	Sept. 14,'96	23 45 0	−28 54 57	eeF. pS. nearly bet. an 8^m * nf & a 9^m * sp. nearer the former, 5th of 5.
50	Sept. 15,'96	23 51 0	−29 37 55	vF. pS. R. 8^m * near sf.

REMARKS.

No. 15. Found searching for Comet 1889 BROOKS after POOR's ephemeris; saw it again June 10, 1896.

No. 33. Found searching for BROOKS's comet 1889.

No. 34. Found searching for BROOKS's comet 1889.

No. 41. Neither this nor the four preceding nebulæ are in N. G. C. No. 38 may possibly = No. 1459 of DREYER'S index catalogue.

IS *MARS* INHABITED?

BY PROFESSOR C. A. YOUNG.

For some reason not quite obvious to the professional astronomer, there seems to be an extreme popular interest in the question of the habitability of "other worlds," and of late it has been greatly intensified by the rather sensational speculations and deliverances of FLAMMARION, LOWELL, and others—speculations based upon new discoveries reported within the last ten or fifteen years, some of which are doubtless real, while others are still more or less questionable.

The editor of the *Herald* has done me the honor to ask me to say to his readers what I think about the matter, and I accept the invitation with pleasure.

I may as well say at the outset that in my judgment we have not yet any satisfactory basis for a confident opinion. The available data are insufficient, and, what is worse, they in some cases seem to indicate opposite conclusions.

As to the general question whether the stars and planets are the abodes of life, we can, of course, say positively on the one hand that they may be. Plainly the Omnipotent Deity can, if He sees fit, organize forms of life suited to any possible conditions, creatures that might flourish in the solar fire, or in nebular fog. On the other hand, there is not the slightest valid evidence that such creatures exist. Considering the "vast emptinesses" between the stars, and the lifeless ages of the Earth's early history, as revealed by geology, one cannot argue that material globes must be inhabited. Unoccupied space, lifeless millenniums, and worlds uninhabited all fall into the same category of unexplained use.

But if we narrow the question, and inquire as to the possibility of forms of life such as we are acquainted with upon the Earth, the case is different. We are able to say at once, and with absolute confidence, that there are only two among all the heavenly bodies observable with our present telescopes upon which anything like terrestrial life could possibly exist. The two are *Venus* and *Mars;* upon all the rest the conditions are clearly too different from our own.

But the limitation must not be lost sight of—there may be, and very likely there are, circulating around some of the distant suns, planets not very unlike the Earth and well enough suited for even human life. But if such planets exist we cannot see them with any telescope yet constructed or ever likely to be. To make them visible would require lenses from 50 to 100 feet in diameter.

Speculation may be allowable in the premises, but dogmatism certainly is not.

As to the planet *Venus*, we need say very little here. In diameter, mass, density, and the force of gravity upon her surface, she is the Earth's twin sister. She is so much nearer than we are to the Sun that she receives from him almost twice as much heat and light as we do; but as to the character of her surface we know almost nothing. Unquestionable observations prove that she has a denser atmosphere than ours, and it is probably always filled with cloud.

At any rate, no distinct and well-marked features have ever been detected on her surface, and there is no reason to suppose that the cloud veil has ever lifted.

With *Mars* the case is different; we know more about him than we do about any other heavenly body, the Moon excepted.

We may reckon up our stock of certain knowledge about this planet somewhat as follows:

In the first place, its orbit is about once and a half as large as the Earth's, and it makes its circuit in 687 days, at a distance from the Sun which ranges between 128,000,000 and 150,000,000 miles, the mean being 141,500,000. Once in every 730 days the Earth overtakes it, passing between it and the Sun; and if this happens in the latter part of August, the distance between us will be the least possible—only about 35,000,000 miles.

No other heavenly body except the Moon and *Venus*, and now and then a comet, ever come so near.

Still this is not so very near after all. Thirty-five million miles is 147 times the distance of the Moon. So that, even with a magnifying power of a thousand (and only the largest telescopes, under the most favorable conditions, can ever use so high a power to advantage), we see the planet's surface just as we view the Moon through a common field-glass magnifying seven times. And most of our observations are made, of course, at a distance much greater than this minimum.

Moreover, since the planet's distance from the Sun averages something more than once and a half that of the Earth, it is certain that *Mars* receives less than half as much solar heat and light as we do—an unquestionable and most important fact.

In the next place, we know that the diameter of *Mars* is about 4200 miles (somewhat more than half that of the Earth), and that it rotates in 24 hours, 37 minutes, 22.65 seconds around an axis so situated that the planet's equator is inclined about twenty-four degrees to the plane of its orbit. This is so nearly the same as the inclination of the Earth's equator, that we may safely infer that *Mars* must have seasons very like those of the Earth, though notably modified by the considerable variations in its distance from the Sun at different parts of its orbit.

In the third place, from the motions of its two little Moons, we can calculate with certainty the weight or "mass" of the planet, and we find it to be less than one-ninth (3-28) that of the Earth. From this it follows also that the planet's average density is seventy-two per cent. that of the Earth; and the force of gravity upon its surface is not quite thirty-eight per cent. as great as here.

A man who here weighs 160 pounds would there weigh only sixty pounds. If he were able here to jump to a height of five feet, there he would jump thirteen. So far as this condition goes, a Martian elephant might be as agile as a terrestrial deer.

Thus far there is no guesswork. We have stated knowledge, not speculation.

Once more. There are clear indications of an atmosphere upon the planet, though they are not such as to enable us to calculate with certainty its extent and density. This atmosphere ought to be much less extensive and dense than ours, on account of the lessened force of gravity, and if the so-called "dynamical theory" of gases, now almost universally accepted among physicists, is true, it must be a little body, like the Moon, or *Mars* cannot permanently retain an atmosphere like our own.

The inference is borne out, too, by the fact that clouds are only rarely observed upon the planet. As a rule we see the features of its surface unveiled and clear. There is probably never a time when a distant observer would be able to see half the seas and continents of the Earth unclouded and exposed to view.

Whether the Martian atmosphere contains any sensible quantity of water vapor is still a debated point. Some of the earlier observers reported that they could distinctly make out the characteristic lines of this substance in the planet's spectrum, but some of the best recent observers, notably Professor CAMPBELL, of the Lick Observatory, have reached an opposite conclusion.

And now we come to a question of great difficulty — that of the planet's temperature.

Since the planet's atmosphere is certainly not dense, it is natural to conclude that the temperature at its surface, even if the Sun's heat there were as intense as here, must be practically the same as that of places on the Earth where the density of the air is correspondingly low, namely, at the tops of the loftiest mountains, in the regions of perpetual snow.

And, recalling that on *Mars* the solar radiation is less than half as intense as here, the inference is almost irresistible that the temperature must be appallingly low—so low that, as on the Moon, water, if it exists at all, can exist only as ice.

And yet, while many astronomers—I myself, for one—are disposed to think this probably true, it is only an inference, and not a certain one. Nor can it be denied, as we shall see, that phenomena observed upon the planet look very much like the deposit and melting of polar snows, the flow of water, and the growth of vegetation.

It may be, perhaps, as FLAMMARION has suggested, that the planet's atmosphere, though rare, has some peculiar constitution that makes it more effective as a "blanket" than our own in its power to retain the solar heat; or it may possibly have some unknown source of heat; or again it may be that FAYE's modification of the nebular hypothesis is correct, and that *Mars*, instead of being an older planet than the Earth, as commonly supposed, may be a younger one, still retaining considerable of its original heat of condensation, and not yet cooled down to a permanent temperature corresponding to its distance from the Sun.

But unless some cause operates to give it an abnormal temperature, the discussion need go no further. Life resembling that upon the Earth could not exist there.

The time may come, perhaps, before very long, when we may have heat-measuring instruments of sufficient delicacy to give us certain information whether the planet's temperature is below zero, or is similar to that of our habitable earth. Till then judgment hangs suspended.

As a telescopic object, *Mars* is fine. Its ruddy disk is diversified with patches of greenish hue, which, in a small telescope, seem to form a sort of irregular bell around its equator, with several projecting angles which thrust themselves down into the northern hemisphere. The telescope inverts the planet much as South America and Africa and India reach toward the south upon a terrestrial globe.

These dark regions cover about a third of the ball, and, until recently, have generally been interpreted as seas and oceans, and are named accordingly. But later observations make this very doubtful by showing such changes in their form and appearance, and such markings upon them as to suggest rather that they are areas covered with vegetation.

Then, near one or the other of the poles, there is usually a "polar cap" of dazzling whiteness, and these caps grow and wane with the planet's seasons (as the elder HERSCHEL discovered more than a century ago), just as they would do if they were composed of ice and snow. Sometimes, also, though rarely, as has been already said, there are whitish veils of cloud that obscure for a time the well-known features, and shortly vanish. All the time the planet whirls, and as the night wears on continents and seas pass slowly in review, coming up from the eastern edge of the disk and descending upon the western.

If the telescope is powerful enough, HALL'S two little Moons will be seen—*Phobos*, hurrying from one side to the other, close to the planet, and so rapidly that it takes him only three hours and three-quarters to make the whole excursion, while the smaller and more distant *Deimos* is more than four times as deliberate in his motion.

But the most interesting objects, if one can see them—for they require a keen eye, a first-rate instrument, and perfect atmospheric conditions—are the fine, dark, thread-like lines which cross the ruddy portions of the disk in various directions, in a most curious and suggestive manner. A few of them were noted (as rather ill-defined shadings), long ago, but it was SCHIAPARELLI, the Milanese astronomer, who, in 1887, first discovered them in

any number, and named them "the canals," as resembling water-courses of some sort, running from sea to sea.

As to their real nature, there is still much doubt. Those who ignore the temperature difficulty, and believe that the polar caps are really sheets of snow which melt in the summer, for the most part accept the suggestion which the names implies, and regard them as marking the track of channels, natural or artificial, through which the water that results from the melting of the ice-caps is distributed over the arid plains near the planet's equator. They suppose — at least, this is the view of FLAMMARION and LOWELL,—that what we see is not the water-course itself, but the fringe of vegetation, which springs up along its banks when the water comes, like the harvests of the valley of the Nile.

And this certainly accords very well with the fact that these canals are not equally visible at all times, but are sometimes fairly conspicuous, while they vanish at others.

Possibly, too, one might deduce from this theory a satisfactory explanation of a very strange phenomenon exhibited by many of them—their "gemination," as it is called. They double themselves at times. A canal which had been a single, thin, dark line is replaced in a day or two by two that are exactly parallel and separated by a distance of from 100 to 250 miles. Some of these canals are over 2000 miles in length, and appear to be as accurately straight as lines can be upon a sphere. They seem to follow a true great circle course.

At their points of intersection — and in several instances, as many as half a dozen seem to converge as accurately to a single point as railroads to a city — small dark spots appear, which have received the name of "lakes." Mr. Lowell, however, prefers to call them "oases," believing them to be patches of vegetation which are formed where the converging channels bring an especially abundant supply of moisture.

And the fact that, according to SCHIAPARELLI and the Flagstaff observers, some of the canals appear to invade, and pass across, the so-called "seas," of course, proves, unless there is some error or illusion in the observations, that these darkly shaded regions are not bodies of water, but marshes, fields, or forests.

We should have noted, as removing a natural objection to this water-course theory of the "canals," that so far as can be judged from observations, the planet's surface is much more level than

that of the Earth. There is no evidence of lofty mountain ranges, though a few projecting bright spots have been noted at the boundary of day and night on the planet's surface, which may indicate elevations having the height of two or three thousand feet.

And it is to be admitted also, I think, that no other explanation of the "canals" as yet proposed satisfies the reported appearances so well as that of water-courses. The only one not absolutely contradicted by direct observations is that they are fissures and wrinkles in the planet's crust, produced by its shrinkage over a comparatively unyielding nucleus. But, then, what is to be made of their "gemination"?

We have thus set forth the conditions of the planet so far as they appear to bear upon its possible habitability by living beings, resembling in essential characteristics those that inhabit the Earth. If we put aside, as FLAMMARION and LOWELL have done, rather airily, we think, the serious difficulty as to temperature, and assume with them that the planet's water-supply is extremely scanty — which can hardly be doubted, if water exists there at all, — and that the planet's surface, for the most part an arid waste, is to some extent made fertile by the channels which distribute the water derived from the melting polar snow-caps, it is clear that we have a condition of affairs which might make habitability of the sort contemplated a not absurd hypothesis.

And yet the great difference between the Earth and *Mars* as to thinness of the atmosphere, the absence of clouds, and the lessened force of gravity and solar radiation must necessitate a wide difference between the inhabitants of the two worlds.

Next comes the question whether, granting the possibility of life upon the planet, we have any evidence of its existence.

As regards vegetable life, its existence is, of course, assumed in the very plausible explanation which LOWELL and FLAMMARION give of the "canals," and the seasonal changes observed in the features of the planet's disc. And they go further. Mr. LOWELL finds evidence of intelligent design and engineering skill in the—according to him—perfect straightness of the long water-courses and the precision with which numbers of them converge to or diverge from certain centers. And he enters into interesting speculations as to the ability of the people of *Mars* to perform feats of engineering quite beyond our human powers.

In the first place, owing to the feebleness of gravity there, the

"men" of *Mars* might attain a strength and stature nearly three times as great as ours without encumbrance from their own weight, and dealing, as they would have to, with rocks only a little more than a third as heavy as they would be here, their work would be greatly more effective.

Then, too, LOWELL, basing his speculation upon the generally received form of the nebular hypothesis (which, contrary to FAYE'S theory, makes *Mars* an older world than ours), argues that the Martians already possess the engineering skill, machines, and appliances which we shall have upon the earth some ages hence.

Human beings may then find themselves upon a world nearly dried up, and may have to undertake irrigation on a scale suggested by what we see upon our neighbor.

Both LOWELL and FLAMMARION remind us, however, very properly, that we must beware of assuming that the "men" of *Mars*—its intelligent inhabitants—are vertebral bipeds like ourselves. If intelligent beings exist there, the probabilities are strong that they are very different from us in ways which we can hardly conjecture, since the difference between the Earth and *Mars* in physical conditions must almost necessarily have determined different lines of development on the two planets. FLAMMARION suggests, in a caprice of speculation it would seem, that the Martians are winged creatures, but whether bats, birds, or butterflies he does not attempt to decide.

There has been some speculation as to the possibility of establishing communication with our hypothetical neighbors, and some enthusiastic amateurs have reported glittering spots upon the planet's disc, and have tried to interpret them as hailing signals from the distant world.

These "lights," however, were, in all probability, mere reflections from favorably situated surfaces of the same material that compose the polar caps; and there is not the slightest probability that with any instruments we now possess we could distinguish any signals they could make. And if we could, who could read them?

Still, it is always wise to be reticent in denying the possibilities of the future, and no less so to be cautious in accepting as ascertained truth the startling conclusions and unverified discoveries of imaginative observers. It is so easy to see what one expects and wishes to find, especially on a disc so small and delicately marked as that of *Mars*.—Boston *Herald*, October 18, 1896.

PRINCETON, N. J., October 10, 1896.

DISCOVERY OF THE COMPANION TO *PROCYON.*

By J. M. Schaeberle.

This morning I discovered a companion to *Procyon*, of about the thirteenth magnitude, in position-angle = 318°.8; distance = 4″.59.

The two sets of measures are as follows:

Telescope west of pier; *Procyon* east of meridian	P = 319°.66 D = 4″.58	Weight 2.
Telescope east of pier; *Procyon* west of meridian	P = 317°.20 D = 4″.60	Weight 1.

It is quite probable that the observed perturbations of *Procyon*, ascribed by Bessel to a theoretical companion, are caused by this newly discovered star. The position-angle of Professor Auwers' theoretical perturbing body is about 275°.

The companion is yellowish in color and sharply defined. Assuming it to be the perturbing body, its mass is about one-fifth of the mass of *Procyon*.

Lick Observatory, November 14, 1896.

MEASURES OF *SIRIUS.*

Made with the Thirty-Six-Inch Equatorial of the Lick Observatory—Robert G. Aitken.

On Saturday morning, October 24th, I turned the large equatorial of this observatory upon *Sirius* and saw the companion. Since then I have made two additional measures, and Professor Schaeberle has made two, which he has kindly given me to publish with mine. Neither of us saw any star in the position given by Dr. See (*Astronomical Journal*, 385).

Our measures are:

1896.	P. S. T.	θ	ρ	Seeing.	Observer.
October	23.65	189°.0	3″.81	5	A
"	28.65	188 .5	3 .57	3	A
"	28.65	188 .3	3 .65	3	S
"	30.60	190 .0	3 .65	5	S
"	30.65	190 .6	[4. ±] est.	4	A

Mt. Hamilton, October 31, 1896.

ELEMENTS AND EPHEMERIS OF COMET *f*, 1896, (PERRINE).

By F. H. Seares.

The following elements and ephemeris of comet *f*, 1896, (Perrine), have been computed by Mr. Crawford and myself, from observations made at the Lick Observatory by Mr. Perrine on November 2d, 3d, and 4th.

The observations were sent by telegraph to the Students' Observatory by Dr. Holden.

$$T = 1897 \text{ January } 23.6384 \text{ G. M. T.}$$

$$\left.\begin{array}{l} i = 145^\circ \quad 55' \quad 22'' \\ \Omega = 79 \quad 52 \quad 47 \\ \omega = 138 \quad 59 \quad 40 \end{array}\right\} \text{Mean Equinox, 1896.0}$$

$$\log q = 0.172302$$

Representation of the middle place:

$$O - C. \quad \Delta\lambda \cos\beta = -3''.7. \quad \Delta\beta = +0''.9.$$

EPHEMERIS FOR GREENWICH MEAN MIDNIGHT.

	α			δ		log ρ	Br.
Nov. 11.5	20^h	8^m	29^s	$+18^\circ$	$23'.3$	0.219	0.92
15.5	20	4	17	15	42 .8	0.235	0.88
19.5	20	0	56	13	16 .7	0.251	0.84
23.5	19	58	19	+11	4 .0	0.267	0.81

The brightness on November 2d is taken as unity.

Students' Observatory, University of California, November 13, 1896.

BENJAMIN APTHORP GOULD.

By R. H. Tucker.

A life of devotion to science and of high achievement has closed. While fitting record of the wide extent of Doctor Gould's contributions to astronomy will be made by others, it is proper to give expression to the admiration and esteem which he inspired in the many, to whom came the opportunity to share in his pursuits.

His was an example of untiring energy and of intense appli- tion, and the results of his labors are of a solid and enduring character. He had the distinction of being the first American astronomer, educated as such, and the influence of the great men of that past generation, ARGELANDER, GAUSS, and ARAGO, with whom he studied, may have strenghtened the bent of his own talent for thorough and substantial work. He had the faculty of inciting the strongest zeal in those who labored for him and with him, while his sympathy and encouragement strengthened the bond which held them in a common cause. Not otherwise could the results of the Cordoba Observatory have been accomplished. They form almost an epitome, for the Southern sky, of the needs of astronomy in the department of star positions —the Uranometry, for standard magnitudes of the brighter stars; the Zones, embracing a network of well-distributed stars, whose places are exact enough for reference in differential measures; and finally, the General Catalogue, giving more thoroughly determined places for the more important stars. With the Durchmusterung, included as a possible undertaking in the original scheme of Doctor GOULD, but carried out after his departure, these several Catalogues represent in general the steps required for the determination of stellar places, and nearly in the order followed in the survey of the Northern heavens.

Mention should not be omitted of the early and successful photographs of star clusters, taken at Cordoba, which will furnish such record of those wonderful aggregations in the southern sky as could be obtained in no other way. They are in no sense to be treated as mere pictures, and remembrance is quite vivid of the gentle repulse given to a collector, who desired some for that purpose. The plates have been undergoing exhaustive measurement in this country; and many stars of the clusters were observed with the meridian-circle at Cordoba, for reference points.

Perhaps the incident referred to may be an illustration of the stand taken by Doctor GOULD early in his career, and adhered to throughout. Belonging to the old regime, he did not favor much popularizing of astronomy, and was strongly opposed to the notoriety that comes through the daily papers, and to the publication of immature work. The usefulness to science was the object striven for, and to this end the energies of the observatory were bent, without division of endeavor. Success in that aim attained, there was no striving for personal eclat.

With his associations formed in this country, and strong ties to hold him here, the life in Cordoba was, in a sense, one of exile, only to be taken up with so worthy an object. To his younger assistants the novelty of a somewhat unconventional life in a new country had, doubtless, its attractiveness. The kindly and familiar intercourse there established, never losing in dignity, became closer, and was more appreciated in a foreign land, not, indeed, without charm of its own.

Since his return to this country, Dr. GOULD'S interest had been mainly given to the *Astronomical Journal*. His later years have been filled with the peaceful calm that follows active endeavor, and the happiness that is sometimes the reward of unselfish devotion. The lines of Dr. HOLMES, in "The Iron Gate," when Age lifts the door-latch, seem to picture these closing years.

"What though of gilded bawbles he bereaves us,
Dear to the heart of youth, to manhood's prime;
Think of the calm he brings, the wealth he leaves us,
The hoarded spoils, the legacies of time!

"Altars once flaming, still with incense fragrant,
Passion's uneasy nurslings rocked asleep;
Hope's anchor faster, wild desire less vagrant,
Life's flow less noisy, but the stream, how deep!"

NOTICES FROM THE LICK OBSERVATORY.

PREPARED BY MEMBERS OF THE STAFF.

ATLAS PHOTOGRAPHIQUE DE LA LUNE, PUBLIÉ PAR L'OBSERVATOIRE DE PARIS, EXÉCUTÉ PAR MM. LOEWY ET PUISEUX. *Premier fascicule*, Paris, 1896. *Mémoire* et *Atlas* de six planches.

The library of the Lick Observatory has just received the magnificent Atlas of the Moon published by the Paris Observatory, from negatives taken with the equatorial *coudé* by MM. LOEWY and PUISEUX, and reproduced in heliogravure by the care of M. FILLON. The original negatives were some six and a half inches in diameter, and they have been subsequently enlarged in the camera fourteen or fifteen diameters to the scale of publication.

The operations required for the production of lunar maps are of three sorts:

1st. To obtain suitable negatives. (Only a few of the very first excellence have been obtained in the past two years at Paris, owing to unsteady air, and at all observatories the very best conditions are required.)

2d. Enlargement of the original negatives on glass in the camera. (Each negative is enlarged to the greatest size which is advantageous at Paris.)

3d. Reproduction of the enlargements on paper. (Heliogravure has been chosen for the Paris Atlas.)

The best focal negatives obtained at Paris and at Mt. Hamilton appear to be of the same order of excellence. This is shown by comparing silver-prints of enlargements by Professor WEINEK from various Paris and Mt. Hamilton negatives. There is little to choose between them. Both are very good.

Direct enlargements in the telescope are extremely advantageous on many accounts, but they are difficult to make when large instruments are employed. (See *Publications* of the Lick Observatory, Vol. III, p. 16). This method has been tried at Paris and abandoned for the present. It was unsuccessful at Mt. Hamilton until 1895, when Mr. PERRINE made changes in our driving-clock, which have allowed us to use it to great advantage. The devices applied by Mr. PERRINE were but makeshifts; and it is only in 1896 that the necessary funds have been obtained for providing suitable change-wheels for lunar rate (and these have not yet been received from the makers).

The CRAMER Dry Plate Company has lately been able to supply us with extremely rapid emulsions, which have allowed us to reduce the exposure-times for direct enlargements to ten seconds, or even to five seconds. Short exposures are the chief factors in such celestial photographs.

The direct enlargements at Mt. Hamilton give an image of the Moon some twenty-six inches in diameter, and the resulting plates are, of course, of relatively finer grain than the focal images. They have been enlarged on glass, by Mr. COLTON, to the scales of III feet, VI feet, and X feet to the Moon's diameter with excellent results. The VI-foot scale shows, however, everything that can be seen in the X-foot enlargements, and the III-foot shows nearly all that is given by the VI-foot, though the details are not so readily seen, of course.

Baron A. v. ROTHSCHILD, of Vienna, has also enlarged several of our focal negatives (on carbon) to the VI-foot scale, and Mr. NIELSEN and Professor PRINZ have done the same. Many negatives of the Moon have been taken by Professor W. H. PICKERING at the Harvard College Observatories at Cambridge and Arequipa, some of them being excellent, but none have yet been published, I believe.

On account of the great expense of publication (a very important point at Mt. Hamilton), the Lick Observatory has decided to issue its Observatory Moon Atlas on a scale of III French feet (38.36 English inches, 97.45 *cm.*) to the Moon's diameter. This is the scale of MAEDLER'S and LOHRMANN'S charts, and one-half that of SCHMIDT'S. The negatives taken in the telescope are slightly enlarged (by Mr. COLTON) in the camera, and are reproduced for publication by the gelatine process by the New York Photogravure and Color Company, 241 W. Twenty-third Street, New York City.

Trials of the heliogravure process and of direct carbon printing were made before adopting the gelatine process (which is much less expensive than either of them). It appears to be true that in America, at least, neither of the foregoing processes can be depended on to give as good and uniform results as the gelatine method.

Focal negatives of the Moon are regularly taken at Mt. Hamilton (by Messrs. HOLDEN and COLTON), and some of them are sent to the Observatory at Prag, where Professor WEINEK enlarges them to a scale of about X feet to the Moon's diameter. He proposes to issue an atlas of the Moon in sheets about 9½ x 11½ inches to the X-foot scale. Silver prints of most of Professor WEINEK'S enlargements (several hundred in number), have been sent to the Lick Observatory. Heliogravure and gelatine prints are permanent. Silver prints will deteriorate with time, though they have several advantages over any mechanical process of publication.

Every method of reproduction necessarily introduces a *grain* which is not in the original negative. The silver print seems to introduce less *grain* than any other process. So far as my limited experience goes, the *grain* from carbon printing and from heliogravure is about the same, and that due to the gelatine process is less objectionable than either. The gelatine prints require careful handling to prevent smearing, which is a drawback. A careful comparison has been made of the Paris charts with reproductions of the Lick Observatory negatives on gelatine (III-foot), by direct carbon printing (III-foot), with Baron v. ROTHSCHILD'S carbon enlargements (VI-foot), with Professor WEINEK'S silver-print enlargements (X-foot), and with Mr. COLTON'S enlargements on glass (VI-foot and X-foot), with particular reference to determining the special excellence of each process of reproduction. It appears to show conclusively that the silver-prints of Professor WEINEK (X-foot scale) come nearer to technical perfection than any other, in that they most successfully reproduce the grain of the original negative and therefore are best fitted to show the finer details of the lunar surface. (Compare, for example, Professor WEINEK'S enlargement of *Archimedes* and vicinity from the Lick Observatory focal negative of 1893, August 3d, with the same subject shown — on a smaller scale — in the Paris chart of 1894, February 13th.) Professor WEINEK'S scale is, in my opinion, somewhat too large for general use. It is particularly suitable for special studies.

The general effectiveness of the Paris heliogravures is, on the other hand, wonderfully fine, and superior in this respect to any reproductions I have seen, except those on glass by Mr. COLTON. As glass diapositives cannot be widely distributed, such heliogravures as the Paris maps must hold the palm for plastic excellence.

Copies on glass of some of the Mt. Hamilton negatives can be seen, however, in Paris (Astronomical Society of France, National Observatory); in London (Royal Astronomical Society, British Astronomical Association); in Berlin (Royal Academy of Sciences); in Rome (Accademia dei Lincei); Copenhagen (Royal Observatory); Washington (Smithsonian Institution); etc., etc.

The grain of the gelatine reproductions of the Lick Observatory direct enlargements is very much finer than that of the Paris maps (as it should be, considering the advantage of working from original negatives twenty-six inches in diameter), though the original grain of the negatives is not reproduced. It is to be remarked, however, that the grain of different gelatine prints differs from print to print, but it is fine in all. The effectiveness —relief—of the Lick Observatory maps is satisfactory.

It is important that the various prints from a single negative should be uniform in quality. This uniformity can be readily obtained in silver printing. In heliogravure and in the gelatine process it must be secured by careful proof-reading. In the direct carbon printing and enlargement it is not so easy, so far as my very limited experience goes. The method of reproduction chosen by Professor W. PRINZ* is not as satisfactory as any of the foregoing processes.

The above comparisons refer only to the excellence of the several processes of reproducing the data of a given negative. It is important to recollect, also, that in such reproductions one may work for two quite different results.

1st. The effort may be to attain the boldest relief possible—to give the resulting maps the greatest plastic effect. To accomplish this end the resulting plate must be made as sharp and precise as practicable (the edges of craters as definite as possible, for example) and the contrasts of light and shade on the moon must consequently be exaggerated—made more harsh.

2d. The effort may be to retain, in the reproductions, the greatest amount of detail (on the bright illuminated surfaces just

* See *Publications* A. S. P., Vol. VI., page 296.

within the rims of craters, for example) and to preserve the faint contrasts on the moon in their true values, so far as may be. (Compare the frontispiece to *Publications* of the Lick Observatory, Vol. III., with the first plate of the Paris maps.) Both effects cannot be successfully obtained from a single negative. The Paris maps seem to have been made with the first object in view, if I am not mistaken. At any rate, they have most successfully attained it.

The Mt. Hamilton enlargements have been purposely made with the second object in mind; and they have, I think, attained it.

The effort of Professor WEINEK has been to reproduce the minutest particularities of the original negative; and he has certainly accomplished this end.

The results, 1st and 2nd, may be consciously sought for by the astronomer in making his enlargements on glass, or they may be forced upon him by the processes of heliogravure. A good example of *unnecessary* sharpening and consequent loss of detail within the high lights (with a gain of precision at the terminator) is shown in the plate facing page 39, of Vol. III, *Publications* of the Lick Observatory (see the remarks on page 15, *op. cit.*)

The maps of Professor WEINEK are on the X-foot scale; those of the Paris charts are of varying scales ($2^m.58 = 101.57$ inches; $2^m.50 = 94.49$ inches); those of the Lick Observatory are of III-feet. The Paris Atlas sheets are 24 x 30 inches; those of the Lick Observatory are 16 x 20 inches. The latter size seems to be as large as is convenient for use at the telescope, though the Paris charts are considerably more impressive.

The *Memoir* accompanying the Paris charts contains many excellent remarks upon lunar charts, and upon the topography and physical condition of the Moon, which there is no space to refer to here. The great advantage of lunar photographs over even the best lunar drawings is insisted upon. It is pointed out that drawings must be executed over relatively small areas at a time, and that it is practically impossible to fit these drawings together subsequently with strict accuracy. The same remark applies to all attempts to make a complete map of the Moon by combining drawings with photographs.

Finally, it may be said that the Paris lunar charts already published constitute a splendid contribution to science. Their plastic relief is unrivaled and is not likely to be surpassed. Taken together with other maps and charts now published, or to

be published (WEINEK, Lick Observatory, PICKERING, NIELSEN, FAUTH, PRINZ, SCHMIDT, LOHRMANN, GAUDIBERT, KLEIN, MAEDLER, NEISON, etc.), they provide a sure basis for a present scientific account of the lunar surface and promise future results of great importance. EDWARD S. HOLDEN.

MT. HAMILTON, November 3, 1896.

METEOR SEEN AT NOON (NOVEMBER 1).

A meteor, leaving a broad scintillating track, traversed fifteen degrees of the northwestern heavens at about ten minutes past noon yesterday. It was seen at a point about thirty degrees above the horizon, and in the half second of its flight shone as an electric light. The shooting star was seen by a visitor at the Park, in San Francisco.—*S. F. Chronicle*, November 2.

A BRIGHT METEOR SEEN ON OCTOBER 8, 1896.

Mr. P. PERRINE, of Alameda, reports a meteor four or five times as bright as *Venus* on October 8, 1896, at 7^h 32^m P.M. It was of a brilliant white color and moved rapidly from an altitude of about thirty degrees to near the horizon, inclining toward the east at an angle of about forty-five degrees. C. D. P.

THE METEOR OF OCTOBER 22, 1896.

In the evening of October 22d, while in Oakland, I saw an unusually interesting meteor. I first saw it a little north of west, where it seemed to rise like a sky-rocket, which it so much resembled that at first I had no thought of its true character. Its apparent motion after the first few seconds was almost exactly parallel to my horizon. At first sight the head appeared to be single, but after two or three seconds (during which time it rapidly increased in brightness), it separated into four parts but not with the usual explosive effect, for all the parts pursued the same course in a straight line, each leaving its train of sparks which reached to the next part, a long train following all. The last portion was much the faintest and soon disappeared, while the remaining three were of more nearly equal brightness, the first being somewhat brighter than the others.

After traversing an arc of ninety degrees or more, they all disappeared at 6^h 9^m $30^s \pm 10^s$ P. S. T. in the smoke of the city

and behind the Berkeley hills. When at their brightest, each portion considerably surpassed *Venus* in brilliancy.

The apparent motion was remarkably slow, the meteor being visible for about ten seconds. C. D. PERRINE.

MOUNT HAMILTON, October 31, 1896.

ABSTRACT OF A LETTER FROM MR. D. J. BROWN TO PROFESSOR HOLDEN.

"LAST CAMP," NAPA, October 23, 1896.

"At about six o'clock, P.M. yesterday, there appeared in this vicinity a meteor of such remarkable appearance that I deem it proper to report its passage to you.

"It came from the west—its flight was quite near the Earth, and speed slower than that of any other like body I have ever seen. At first it had a solid head, with a train of considerable length. Soon this head divided into three parts, presenting an appearance like this,* slowly passing over the valley in the direction of Napa Soda Springs. It went to pieces like a spent sky-rocket."

LETTER FROM MR. H. F. STIVERS, AT HUNTER'S, TEHAMA COUNTY, CAL., OCTOBER 26, 1896.

"Seeing a meteor, the other evening, that appeared to me more than ordinary, I have roughly sketched and described its appearance and would be pleased to know if it was seen at the Observatory. Friday, October 22d, at 6:10 P. M., P. S. T., I saw a very brilliant meteor in the west. My attention was drawn to it by the great light it gave. At first view it was not more than fifteen or twenty degrees above the western horizon. It sailed majestically along like an immense rocket directly towards the Moon, and disappeared in the Moon's light, not more than ten degrees from that luminary. Its zenith was about ten degrees north of mine, on passing which it separated twice, making plainly visible three pieces, the largest the apparent size of a closed hand, the others diminished to about one-half each.

"It was visible from ten to fifteen seconds, and had a trail of twenty-five or thirty degrees.

"It emitted a white light, tinged at times, I should judge, with

* The sketch is omitted.

red and yellow. It must have described the complete arc of the heavens and had it not been for the brightness of the full moon, should nearly all have been observable by me."

NOTE.—The accompanying sketch has not been reproduced.

WHEATLAND,* October 22.—A most remarkable meteor was seen a few minutes past 6 o'clock this evening. It appeared in the west as a star of the magnitude of the evening star, and in close proximity to Jupiter.† It increased in size and gradually separated, first into two and finally into three distinct comet-shaped bodies. Following each other they sped toward the east and disappeared.—*S. F. Chronicle.*

HIGHLAND SPRINGS, October 23.—At 6:13 o'clock, last night, a meteoric display, such as is seldom seen, passed over here. It was composed of three large balls of fire moving from southwest to northeast. It looked as if the balls burst on the mountain north of Clear Lake.

THREE METEORS IN LINE.

NEVADA, CAL., October 22.—A triple connected meteor was observed in the northern heavens at ten minutes past 6 o'clock this evening. Three balls of fire, all in a row and connected like a train of cars, with a long fiery tail, flashed in view just a few degrees above the western horizon and traveled in a direction a little north of east. In half a minute they disappeared from view high in the heavens, apparently somewhere over the Great Dipper and North Star.

The sight was magnificent and awe-inspiring, and one long to be remembered, as it did not appear to be over forty or fifty miles above the earth. A splendid view of the triple-connected meteor was taken by W. M. Richards.—*S. F. Examiner*, Oct. 23, 1896.

This meteor was also seen by many visitors at the Cliff House, near San Francisco.

ON THE FORM OF THE CORONA OF AUGUST 9, 1896.

The Lick Observatory has just received three good positive copies of photographs of this eclipse, taken in Lapland by Dr. L. WUCHIKHOWSKY. A naked-eye sketch also accompanied

* Yuba County, California. † *I. e. Venus.*

the photographs. Professor HOLDEN has handed these over to me for examination.

A good illustration of how unsatisfactory and unreliable eye sketches are, is again shown by comparing the sketches, so far published in the various scientific journals (and the one above mentioned) with these photographs. In the sketches there is apparently no law of distribution of coronal matter with reference to the Sun's equator, while in the photographs the general form of the corona is in agreement with the form predicted by means of the "Mechanical Theory," being characterized by great polar extension, causing a tendency towards a nearly circular outline. See *Lick Observatory Report on the Eclipse of December, 1889*, page 76, Table V, and Plate VI, Figures 5 and 8.

It is a significant fact, that while this eclipse took place near the time of the sun-spot minimum, the coronal form corresponds to the type of coronas which astronomers have quite generally considered as belonging to the times when the Sun is most spotted.

J. M. SCHAEBERLE.

LICK OBSERVATORY, November 6, 1896.

PROPOSED GIFT TO THE UNIVERSITY OF CALIFORNIA BY MRS. PHŒBE A. HEARST.

The daily papers of October 25th announce that it is the intention of Mrs. HEARST to present to the University of California two buildings to be erected at Berkeley. It is also said that it is Mrs. HEARST'S intention to endow, at least, one of the colleges at Berkeley. A Board of Trustees has been appointed to carry out Mrs. HEARST'S plans.

The university has long since outgrown its buildings; and there is probably no way in which its interests can be so efficiently furthered as by the provision of a group of buildings specially designed for their purposes and of high architectural excellence.

E. S. H.

October 26, 1896.

REQUEST FOR OBSERVATIONS OF COMET IV, 1895.

I have undertaken the definitive orbit of Comet IV, 1895, and shall be glad of any unpublished observations.

C. D. PERRINE.

MT. HAMILTON, October 19, 1896.

List of American Learned and Educational Societies.

Prepared by Dr. Stephen B. Weeks.

The attention of members of the society is called to an excellent article with the foregoing title printed in Chapter XIII (pages 1493–1661) of Vol. II, of the *Report* of the United States Commissioner of Education, for the year 1893–94, just issued.

E. S. H.

Scientific Visitors to the Lick Observatory.

Professor Kayser.

We had the pleasure of a scientific visit from Professor Kayser, of the University of Bonn, on October 5th, 6th, and 7th. The weather was excellent (except for smoke in the valleys from extensive forest fires) and representative of our usual summer conditions, and Professor Kayser was able to see many objects of which observations have been made here, particularly the spectra of interesting and type objects. E. S. H.

The Meeting of the Astronomische Gesellschaft at Bamberg (1896)—Greetings to their Colleagues in California.

On October 7th, the mail brought a post-card addressed to the Lick Observatory inscribed as follows:

"From the XVI Astronomical Congress (Bamberg). Send Greetings."

"Auwers, Dr. J. Bauschinger, Prof. E. Becker, Strassburg, Martin Brendel, C. V. L. Charlier, F. Cohn, Dr. G. Eberhard, F. Folie, J. Franz, Dr. Ernst Hartwig, Bamberg, J. Holetschek, P. Kempf, Otto Knopf, Jena, H. Kreutz, Editor ad. int. Ast. Nach., Lehmann-Filhés, Mr. and Mrs. A. O. Leuschner, Dr. Messerschmitt, Zürich, M. Nyrén, J. A. C. Oudemans, J. Palisa, C. F. Pechüle, Dr. M. Schmidt, R. Schorr, Hamburg, W. Schur, Göttingen, H. Seeliger, R. Steinheil, B. Wanach, Prof. Dr. E. Weiss, Vorsitzender, W. Winkler, Jena, (and at least one more name not to be deciphered.)

These cordial greetings are highly welcome. They emphasize the fact that science has nothing to do with boundary lines.

Wherever the members of the Astronomische Gesellschaft may be, they have a common cause, and, in a sense, a common country. E. S. H.

1896, October 8.

Mt. Helena visible from Mt. Hamilton.

Mt. Helena, 4343 feet high, is situated at the head of the Napa Valley, California. It is visible from Mt. Hamilton, at a distance of about 105 miles.

The highest (west) point of this mountain bears $30^\circ\ 15'$ west of true north from the Transit House of the Lick Observatory.

C. D. Perrine.

Lick Observatory, October 31, 1896.

Comet *f* 1896 (Perrine).

This comet was discovered about 10 p.m., November 2d, in the constellation *Vulpecula*. Its position at $19^h\ 13^m\ 3^s$ G. M. T., was R. A. $20^h\ 21^m\ 36^s.33$; Decl. $+\ 25^\circ\ 6'\ 39''.8$. Its motion was nearly 2^m west and $50'$ south per day. From Mt. Hamilton observations of November 2d, 6th, and 11th, I have derived the following parabolic elements:

$$T = 1897 \text{ February } 8.15286 \text{ G. M. T.}$$

$$\left.\begin{aligned} \omega &= 172^\circ\ 37'\ 36'' \\ \Omega &= 86\ \ 28\ \ 00 \\ i &= 146\ \ \ 8\ \ 42 \end{aligned}\right\} 1896.0$$

$$q = 1.0571$$

Residuals: $(O-C)\ \Delta\ \lambda \cos \beta - 4''$; $\Delta\ \beta - 1''$.

The comet is faint, not being brighter than a star of 10½ or 11 magnitude, and has a stellar nucleus of about 13 magnitude. It has a well-marked central condensation, and is about $2'$ in diameter. Its distance at discovery was about 140,000,000 miles, and is slowly increasing, the comet consequently growing fainter.

C. D. Perrine.

Lick Observatory, November 16, 1896.

Decoration for Professor Holden.

The Director of the Lick Observatory has received the diploma and decoration of Knight of the Order of the Dannebrog, of Denmark, for services to science.

COMPLETION OF THE WASHINGTON ZONE —13° 50′ to —18° 10′.

[Extract from a private letter of Mr. A. N. SKINNER.]

. . . "It may interest you to know that about three years ago I was put in charge of the PISTOR and MARTEN'S Transit-Circle, and ordered to execute the observation of the Gesellschaft Zone —13° 50′ to —18° 10′. I entered vigorously upon it at once, and was highly favored in having two competent assistants —FRANK B. LITTELL and THEO. I. KING. The observing was practically finished in two years. I did all the work at the telescope; the assistants recorded and read the microscopes. There are 8689 stars in the Zone. More than 19,000 observations have been made. The reductions are more than half-finished. One minor fruit of the work has been the discovery of four interesting variable stars—X *Hydræ*, W *Ceti*, R. T. *Libræ*, and Z *Capricorni*."

U. S. Naval Observatory,
WASHINGTON, November 11, 1896.

DR. JOHN H. C. BONTÉ (DIED NOVEMBER 24, 1896).

Dr. J. H. C. BONTÉ, Secretary of the University of California during the years 1881–1896, and Professor of Legal Ethics in the Hastings Law School, died in Sacramento, November 24, 1896, at the age of sixty-five years. This is not the place to speak of his long, disinterested, and very valuable services to the University, as its Secretary, Land Agent, and Business Manager. He occupied a difficult position in the midst of conflicting interests, and few will realize to the full the genuine devotion which he brought to his manifold duties.

During the early years of the history of the Lick Observatory, when much was lacking in our equipment, and when the annual appropriations were markedly smaller than at present even, it would have been impossible to have carried on the work of the institution as it has been carried on, had it not been for Dr. BONTÉ'S cordial seconding of the plans of the Director, which had been approved by the Chairman of the Regents' Committees on the Lick Observatory and on Finance, but which could only be made effective by the most scrupulously rigid economy.

He took unusual pains to understand what was wanted; and he spared no labor to make it as easy as possible to realize the

ends desired as quickly as practicable, and this in the face of genuine difficulties. Fortunately, the Observatory has passed through its early difficulties with success, and has entered another period, under new and improved conditions. This change was certain to come sooner or later. That it has come quickly is due in an important degree to his friendly co-operation. So much, at the very least, is due from the Observatory to our departed friend. Those who have cheerfully and faithfully borne the burden and heat of the early days deserve the gratitude of those others who will reap the benefit of their labors.

EDWARD S. HOLDEN.

MT. HAMILTON, Nov. 25, 1896.

ASTRONOMICAL TELEGRAMS.

ROTATION-TIMES OF *VENUS* AND *MERCURY*, ETC.

The following telegram appeared in the daily papers of the United States early in October:

> LOWELL OBSERVATORY, FLAGSTAFF, Arizona, October 6.—The astronomers here have discovered that the planets *Mercury* and *Venus* each rotates once on its axis during its revolution around the Sun. These planets have therefore only one day in each of their years. *Venus* has a dense atmosphere, while *Mercury* has none.

This telegram omits to state that SCHIAPARELLI announced on December 8, 1889,* that his observations from 1882 onwards led to the conclusion that *Mercury* revolved on its axis once in one period of revolution about the Sun; and that he announced a similar conclusion with respect to *Venus* early in 1890.†

As no telegram relating to these important observations reached the Lick Observatory directly, I applied for a copy of the original sent to Boston, which has been kindly furnished by Mr. RITCHIE, as follows:

(Dated) Lowell Observatory,
FLAGSTAFF, A. T., October 5, 1896.

To JOHN RITCHIE, Jr., Boston:

Mercury and *Venus* rotate once on their axes in a revolution round the Sun. *Venus* is not cloud-covered, but atmosphere veiled. *Mercury* not. (Signed) LOWELL.

It thus appears that the original telegram from the Lowell

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* See *Publications* A. S. P., Volume II, page 79. † *Ibid.*, Volume II, page 246.

Observatory simply announces the important fact that the observers have confirmed the conclusions announced by SCHIAPARELLI in 1889 and 1890, and makes no claim whatever to discovery. This point is emphasized here because the wording of the newspaper telegram has been criticized on various sides (*e. g.* in the New York *Sun*, of October 8, 1896), as an injustice to Professor SCHIAPARELLI, although all astronomers, were, of course, familiar with his discovery. The publication of the observations of the Flagstaff Observatory on the points covered by the telegrams will be awaited with interest.

EDWARD S. HOLDEN.

MT. HAMILTON, October 26, 1896.

RE-DISCOVERY OF THE COMPANION OF *SIRIUS*, AT THE LICK OBSERVATORY.

ASTRONOMICAL TELEGRAM.

(Dated) Lick Observatory, Oct. 31, 1896.

To Harvard College Observatory: (Sent 8^h 20^m A. M.)

CLARK'S companion to *Sirius* is in its predicted place. Position, 189°; distance, 3″.7; from three nights measures by AITKEN and SCHAEBERLE. No other companion is visible. Cable.

NOTE.—CLARK'S companion of *Sirius* was last observed at Mt. Hamilton by Professor BURNHAM 1890.27 in. $p=359°.7$, $s=4''.19$. Professor HUSSEY examined the system carefully, during February and March of the present year. (and Professor CAMPBELL, in March, also) and the companion was not to be seen. It was still too close (see *Publications* A. S. P., Vol. VIII, page 183.)

On August 31, Dr. T. J. J. SEE reported that the companion had been re-discovered at the Lowell Observatory, Flagstaff, Arizona, (see *Astronomical Journal*, No. 385) in $p=220°$, $s=5''$. Measures of an object near this place were made by Messrs. SEE, DOUGLASS and COGSHALL; and it was also reported to have been seen by Messrs. LOWELL and DREW. (See HOWARD'S orbit, A. J. Vol. X, page 149).

There is no doubt that the CLARK companion is in $p=189°$, $s=3''.7$; and it is not probable that any other companion exists. E. S. H.

ASTRONOMICAL TELEGRAMS (*Translation*).

(Dated) Lick Observatory, Oct. 15, 1896.

F. H. SEARES, Berkeley: (Sent 7^h 41^m P. M.)

Comet GIACOBINI was observed by HUSSEY and PERRINE, October 4, 16^h 6^m 56^s G. M. T.; R. A. 18^h 20^m $59^s.57$; Decl. $-11°$ $56'$ $40''.8$. [Also on October 7 and 8].

DISCOVERY, ETC., OF COMET *f*, 1896 (PERRINE, NOVEMBER 2).

ASTRONOMICAL TELEGRAMS (*Translation*).

(Dated) Lick Observatory Nov. 3, 1896.

To Harvard College Observatory:
Students' Observatory: } (Sent 8^h 45^m A.M.)

A faint comet was discovered by C. D. PERRINE [at 10 P.M. November 2]. Its position, November 2, 19^h 12^m 0^s G. M. T., was R. A. 20^h 21^m $36^s.30$; Decl. + 25° 6′ 40″. Its motions are — 30′ R. A., — 45′ Decl. daily. Cable.

(Dated) Lick Observatory, Nov. 3, 1896.

To Harvard College Observatory:
Students' Observatory: } (Sent 11^h 10^m P.M.)

Comet PERRINE was observed by PERRINE November 3, 17^h 1^m 53^s G. M. T.; R. A. 20^h 19^m $55^s.50$; Decl. + 24° 21′ 5″.

Lick Observatory, Nov. 4, 1896.

To Harvard College Observatory:
Students' Observatory: } (Sent 7^h 45^m P.M.)

Comet PERRINE was observed by PERRINE November 4, 14^h 34^m 6^s G. M. T.; R. A. 20^h 18^m $21^s.2$; Decl. + 23° 36′ 53″.

(*Translation.*)

Lick Observatory, Nov. 5, 1896.

To Harvard College Observatory: (Sent 9^h 0^m A.M.)

The elements and ephemeris of Comet PERRINE were computed by Messrs. HUSSEY and PERRINE, from the observations of November 2, 3, 4, as follows: Cable.

$$T = 1897, \text{ January } 18.6072 \text{ G. M. T.}$$

$$\left.\begin{aligned} \omega &= 133^\circ \; 8' \; 35'' \\ \Omega &= 78 \;\; 33 \;\; 48 \\ i &= 145 \;\; 52 \;\; 56 \end{aligned}\right\} 1896.0$$

$$q = 1.5441$$

[The ephemeris, at four-day intervals, from November 6th to 18th, is here omitted.]

ASTRONOMICAL TELEGRAMS.

In the *Astronomische Nachrichten*, No. 3384, col. 422, Mr. RITCHIE has a note on the comet reported by SWIFT, 1896, September 20th, in which it is said that "telegrams of request were sent to Lick . . . . and other places." No telegrams were received at Mt. Hamilton other than those printed in what precedes. (*Publ.* A. S. P., Vol. VIII, p. 265.)

BOSTON, November 11, 1896.

To Lick Observatory: (Received 7^h 10^m P.M.)

Mars Trivium Charontis seen double November 10; by FLAMMARION. (Signed) JOHN RITCHIE, Jr.

DISCOVERY OF THE COMPANION TO *PROCYON*.

Lick Observatory, November 14.

To Harvard College Observatory: (Sent 9^h 15^m A.M.)

Professor SCHAEBERLE reports the discovery of the companion to *Procyon*. Position, 318°; distance, 4″.6; magnitude, 13. Cable.

[See a note by Professor SCHAEBERLE elsewhere in this number.]

DISCOVERY OF COMET *g*, 1896 (PERRINE).

A comet was discovered by Mr. C. D. PERRINE on December 8, 1896. The details concerning it will be given in the next number of the *Publications*.

Minutes of the Meeting of the Board of Directors, held in the Rooms of the Society, November 28, 1896, at 7:30 p. m.

President Hussey presided. A quorum was present. The minutes of the last meeting were approved. The following members were duly elected:

List of Members Elected November 28, 1896.

Dr. J. T. Boyd	76 E. Ohio St., Indianapolis, Ind.
Rev. W. Arthur Duckworth, J. P.	Frome, Somerset, England.
Mr. Julius Hansen	218 Forest Ave., Buffalo, N. Y.
Mr. Robert Y. Hayne, Jr.	San Mateo, Cal.
Prof. H. Kreutz	Sternwarte, Kiel, Germany.
Colonel J. G. C. Lee, U. S. Army	New Montgomery St., S. F., Cal.
Mr. D. A. Lehman	College Park, Cal.
Library of the Bureau of Education	Washington, D. C.
New York Public Library	40 Lafayette Place, New York, N. Y.
The Public Library	Boston, Mass.
Library of the University of California	Berkeley, Cal.
Mr. Edward Payson	San Mateo, Cal.
Mr. J. C. Rabe	P. O. Box 301, Mare Island, Vallejo, Cal.
Mr. John S. Townsend	Stamford Lodge, St. Johns, Seven Oaks, England.
Miss Marie B. Wilson	3196 Pacific Ave., S. F., Cal.

The election of Messrs. Hayne, Kreutz, Lehman, Payson, Townsend, and the University of California Library to take effect January 1, 1897.

A communication was received from the California Academy of Sciences, kindly granting the use of the lecture hall of the Academy for the meetings of November 28, 1896, January 30, 1897, and March 27, 1897. Adjourned.

Minutes of the Meeting of the Astronomical Society of the Pacific, held in the Lecture Hall of the California Academy of Sciences, November 28, 1896.

The meeting was called to order by President HUSSEY. The minutes of the last meeting, as printed in the *Publications*, were approved.

The Secretary read the names of new members duly elected at the Directors' meeting.

The following papers were presented:

1. Historical Review of Eclipse Observations (illustrated by lantern slides), by Mr. A. L. COLTON, of the Lick Observatory.
2. The Lick Observatory Eclipse Expedition to Japan, August, 1896, (illustrated by lantern slides), by Mr. C. BURCKHALTER, of the Chabot Observatory.
3. The Total Solar Eclipse of August 9, 1896, as observed in Russia, (with photographs of the Corona), by Mr. ALEXANDER RYDZEWSKI.
4. Discovery of the Companion to *Procyon*, by Prof. SCHAEBERLE, of the Lick Observatory.
5. Re-discovery of the Companion to *Sirius*, by Prof. AITKEN, of the Lick Observatory.
6. Discovery of Comet *f*, 1896, by Mr. C. D. PERRINE, of the Lick Observatory.
7. Measures of 108 Double Stars, by Prof. AITKEN, of the Lick Observatory.
8. Catalogue of 50 New Nebulæ discovered at the Lowe Observatory, California, by Dr. LEWIS SWIFT.

9, 10, 11, 12. Orbits of Comet *e*, 1896, calculated by Messrs. HUSSEY and PERRINE, of the Lick Observatory; SEARS and CRAWFORD, of the Student's Observatory, Berkeley.

13. Planetary Phenomena for January and February, 1897, by Prof. MCNEILL, of Lake Forest, Ills.
14. Kepler, by Dr. EDWARD S. HOLDEN.
15. The photographic Moon-Atlas of the Paris Observatory, reviewed by Dr. HOLDEN.

Mr. A. L. COLTON gave an historical review of eclipse observations, illustrated by lantern slides; commencing with the earliest drawings of the corona, made in 1715, copies of the first successful photographs, made in 1851, and concluding with pictures of the eclipse of August, 1896, made by the Russian Expedition in Lapland.

Mr. BURCKHALTER contributed a description of the recent eclipse expedition to Japan, exhibiting a number of slides of scenes along the route of travel and of the eclipse station and instruments at Akkeshi.

The thanks of the Society were returned to the California Academy of Sciences for the use of the lecture hall.

Adjourned.

OFFICERS OF THE SOCIETY.

W. J. HUSSEY (LICK Observatory), ... *President*
E. J. MOLERA (606 Clay Street, S. F.) . . . . }
E. S. HOLDEN (LICK Observatory), ... } *Vice-Presidents*
O. VON GELDERN (819 Market Street, S. F.) . . . . . . }
C. D. PERRINE (LICK Observatory), ... *Secretary*
F. R. ZIEL (410 California Street, S. F.), ... *Secretary and Treasurer*
Board of Directors—Messrs. EDWARDS, HOLDEN, HUSSEY, MOLERA, Miss O'HALLORAN, Messrs. PARDEE, PERRINE, PIERSON, STRINGHAM, VON GELDERN, ZIEL.
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Committee on Publication—Messrs. HOLDEN, BABCOCK, AITKEN.
Library Committee—Miss O'HALLORAN, Messrs. MOLERA, BURCKHALTER.
Committee on the Comet-Medal—Messrs. HOLDEN *(ex-officio)*, SCHAEBERLE, CAMPBELL.

OFFICERS OF THE CHICAGO SECTION.

Executive Committee—Mr. RUTHVEN W. PIKE.

OFFICERS OF THE MEXICAN SECTION.

Executive Committee—Messrs. CAMILO GONZALEZ, FRANCISCO RODRIGUEZ REY.

NOTICE.

The attention of new members is called to Article VIII of the By-Laws, which provides that the annual subscription, paid on election, covers the *calendar* year only Subsequent annual payments are due on January 1st of each succeeding calendar year. This rule is necessary in order to make our book-keeping as simple as possible. Dues sent by mail should be directed to Astronomical Society of the Pacific 819 Market Street, San Francisco.

It is intended that each member of the Society shall receive a copy of each one of the *Publications* for the year in which he was elected to membership and for all subsequent years. If there have been (unfortunately) any omissions in this matter, it is requested that the Secretaries be at once notified, in order that the missing numbers may be supplied. Members are requested to preserve the copies of the *Publications* of the Society as sent to them. Once each year a title-page and contents of the preceding numbers will also be sent to the members, who can then bind the numbers together into a volume. Complete volumes for past years will also be supplied, to members only, so far as the stock in hand is sufficient, on the payment of two dollars to either of the Secretaries. Any non-resident member within the United States can obtain books from the Society's library by sending his library card with ten cents in stamps to the Secretary A. S. P., 819 Market Street, San Francisco, who will return the book and the card.

The Committee on Publication desires to say that the order in which papers are printed in the *Publications* is decided simply by convenience. In a general way, those papers are printed first which are earliest accepted for publication. It is not possible to send proof sheets of papers to be printed to authors whose residence is not within the United States. The responsibility for the views expressed in the papers printed rests with the writers, and is not assumed by the Society itself.

The titles of papers for reading should be communicated to either of the Secretaries as early as possible, as well as any changes in addresses. The Secretary in San Francisco will send to any member of the Society suitable stationery, stamped with the seal of the Society, at cost price, as follows: a block of letter paper, 40 cents; of note paper, 25 cents; a package of envelopes, 25 cents. These prices include postage, and should be remitted by money-order or in U. S. postage stamps. The sendings are at the risk of the member.

Those members who propose to attend the meetings at Mount Hamilton during the summer should communicate with "The Secretary Astronomical Society of the Pacific" at the rooms of the Society, 819 Market Street, San Francisco, in order that arrangements may be made for transportation, lodging, etc.

PUBLICATIONS ISSUED BI-MONTHLY.

(February, April, June, August, October, December.)